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Maternal Posttraumatic Stress Disorder and Infant Developmental Outcomes in a South African Birth Cohort Study

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Abstract

Objective—To investigate the association between maternal posttraumatic stress disorder (PTSD) and infant development in a South African birth cohort.

Method—Data from the Drakenstein Child Health Study were analyzed. Maternal psychopathology was assessed using self-report and clinician-administered interviews; and 6-month infant development using the Bayley III Scales of Infant Development. Linear regression analyses explored associations between predictor and outcome variables.

Results—Data from 111 mothers and 112 infants (1 set of twins) were included. Most mothers (72%) reported lifetime trauma exposure; the lifetime prevalence of PTSD was 20%. Maternal PTSD was significantly associated with poorer fine motor and adaptive behavior – motor development; the latter remaining significant when adjusted for site, alcohol dependence, and infant head-circumference-for-age *z*-score at birth.

Conclusion—Maternal PTSD may be associated with impaired infant neurodevelopment. Further work in low- and middle-income populations may improve early childhood development in this context.

Keywords

maternal posttraumatic stress disorder; infant development; South Africa; birth cohort

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Introduction

Posttraumatic stress disorder (PTSD) is a debilitating disorder affecting vulnerable individuals who have been exposed to traumatic events. Gender differences in trauma exposure, and in the phenomenology of PTSD have been well-documented (Herman et al., 2009; Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995; Olff, Langeland, Draijer, & Gersons, 2007; Sartor et al., 2011), with females at overall greater risk. The development of PTSD during the prenatal and peripartum periods may be particularly harmful, with potential adverse effects on both mother and child (Morland et al., 2007; Rogal et al., 2007; Seng, Low, Sperlich, Ronis, & Liberzon, 2011). There is a growing body of work documenting the detrimental effects of trauma exposure and PSTD during pregnancy. For example, in their prospective study of 89 offspring (aged 5.5 years old) of mothers exposed to a moderately severe natural disaster, Laplante, Brunet, Schmitz, Ciampi, and King (2008) reported that children exposed to high levels of objective stressors *in utero* scored lower on measures of cognitive and language abilities, compared to those who had been exposed to low-moderate levels of prenatal stress. However, there is a relative paucity of research emerging from low- and middle-income (LMIC) settings. Further, few studies to date have explored specifically the association between maternal trauma exposure or PTSD and infant neurodevelopmental outcomes.

The Drakenstein Child Health Study (DCHS) is a population-based birth cohort study investigating maternal and child health longitudinally in a poor, peri-urban sub-district in the Western Cape, South Africa (Zar, Barnett, Myer, Stein, & Nicol, 2015). This study provides a unique opportunity to investigate the association between maternal trauma and PTSD with adverse birth and developmental outcomes in infancy and childhood in a previously understudied population. Prior studies in this birth cohort have found that this population has a higher prevalence of PTSD than has been reported in nationally representative studies such as the South African Stress and Health Study (SASH; Williams et al., 2007). The purpose of the current analysis was to examine the association between maternal PTSD and infant development at age 6 months. We hypothesized that PTSD would be associated with adverse infant developmental outcomes in this study sample.

Methods

This analysis used a subset of data from the DCHS including a sub-sample of mothers enrolled into the larger DCHS cohort between March 2012 and December 2013. Further details of inclusion/exclusion criteria are detailed below.

Participants

Pregnant women were recruited at 20–28 weeks' gestation from two primary care clinics – TC Newman and Mbekweni – in the Drakenstein sub-district in Paarl, Western Cape. TC Newman serves a predominantly mixed-race community; while Mbekweni serves primarily a Black African community. Mothers are followed throughout pregnancy and childbirth until the index child is at least 5 years old (Zar et al., 2015). Exclusion criteria for this sub-study were age younger than 18 years, residence outside of the Drakenstein sub-district, and intention to move out of the region within 2 years of giving birth.

A total of 734 mothers were enrolled during the period March 2012 to December 2013. Of these, 50 mothers were lost to follow-up between enrolment and delivery, and 10 experienced pregnancy losses (miscarriage or stillbirth). Thus, there were 675 live births (including one set of twins) during this period. Those without completed infant developmental data (n = 498) at the time of the current analysis were excluded. An additional 65 mother-infant dyads were excluded primarily due to missing/incomplete 6-month Mini International Neuropsychiatric Interview (MINI) data (i.e., a total of 563 dyads were excluded). Thus, data from 111 mothers and 112 infants (including one set of twins) were included in the final analysis. While the current subset were found to be less likely to be employed (with lower socioeconomic status [SES]), and more likely to report antenatal alcohol use compared to those mothers excluded from this analysis; there were no other appreciable differences between those included and those excluded.

Ethics

The DCHS was approved by the human research ethics committee of the Faculty of Health Sciences, University of Cape Town (UCT) and by Stellenbosch University in South Africa; as well as by the Western Cape Provincial Research Committee. All study participants provided written informed consent – research activities pertaining to the current sub-study were included in the larger DCHS consenting process. To obtain data regarding relevant predictor and outcome variables, mothers were asked to complete a battery of self-report and clinician-administered measures at an antenatal visit between 28 and 32 weeks' gestation, and at a number of postnatal visits (Koen et al., 2014; Stein et al., 2015; Zar et al., 2015). These tools were administered by trained study fieldworkers in either English, Afrikaans or isiXhosa, thus ensuring completion in the participants' preferred language. Further, study clinicians with the relevant psychiatric experience administered structured interviews to participants in order to determine diagnostic status (see the Measures section). Women were interviewed in private onsite consultation rooms and every effort was made by study staff to maintain confidentiality. Participants were also provided with refreshments and standard reimbursement for transport costs. On completion of the assessment, those participants with suspected psychopathology (including PTSD, depression, and/or substance use) were referred by study staff to the most appropriate care providers in the community, according to a standard operating procedure devised for the purposes of this study. Further, information leaflets designed by the study team were made available to all participants to facilitate autonomous accessing of local health services.

Measures

The comprehensive assessment of enrolled women in this study sample included both self-report assessment tools and clinician-administered diagnostic interviews (Koen et al., 2014; Stein et al., 2015; Zar et al., 2015). All measures had good psychometric properties (reliability and validity) and were suitable for use in the South African context. For the purposes of this analysis, maternal demographic and psychosocial risk factors; maternal PTSD; and infant anthropometric and developmental outcomes were measured, as detailed here.

a. **Maternal sociodemographic characteristics.** A questionnaire to assess SES was adapted from the version used in the SASH (Myer, Stein, Grimsrud, Seedat, & Williams, 2008). Composite SES scores were calculated, and participants were stratified into quartiles, that is, lowest, low-moderate, moderate-high, and highest SES. These quartiles were generated for the purposes of this study and represent an internal comparison for this sample.

b. **Psychosocial risk factors.** The World Mental Health Life Events Questionnaire (adapted from the SASH; Myer et al., 2008) was used to assess exposure to stressful/negative life events during the past 12 months. The Beck Depression Inventory is a widely-used and reliable screen for depressive symptoms (Beck, Steer, & Brown, 1996; Beck, Steer, & Garbin, 1988; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). The Edinburgh Postnatal Depression Rating Scale (Cox, Holden, & Sagovsky, 1987) is a 10-item self-report measure of recent depressive symptoms, with good psychometric properties (Eberhard-Gran, Eskild, Tambs, Opjordsmoen, & Samuelsen, 2001). The Self-Reporting Questionnaire (SRQ-20; Harding et al., 1980; Scholte, Verduin, van Lammeren, Rutayisire, & Kamperman, 2011) was used as a measure of psychological distress in our study. Substance misuse was assessed using the World Health Organization's (WHO's) Alcohol, Smoking and Substance Involvement Screening Test (WHO ASSIST Working Group, 2002), a reliable, feasible and validated questionnaire.

c. **Trauma exposure and lifetime PTSD**. The Childhood Trauma Questionnaire (Bernstein et al., 1994) is a 28-item inventory assessing childhood abuse and neglect. The Intimate Partner Violence (IPV) Questionnaire was adapted from the WHO multicountry study (Jewkes, 2002) and the Women's Health Study (Zimbabwe; Shamu, Abrahams, Temmerman, Musekiwa, & Zarowsky, 2011) and assessed lifetime and past-year exposure to emotional, physical and sexual abuse. The clinician-administered MINI is an abridged version of the Structured Clinical Interview for the *Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM–IV)* (Lecrubier et al., 1997; Sheehan et al., 1997, 1998) and was used to obtain more comprehensive data on trauma exposure (as defined by the *DSM-5* criteria; American Psychiatric Association, 2013) and psychopathology (PTSD, depression) at a number of longitudinal timepoints. For the purposes of this study, maternal phenotype data from the 6-month postpartum MINI assessment were used.

d. **Infant outcomes.** *Anthropometry* (weight, head circumference, length/height) at birth and 6 months was measured by trained clinical staff, and the relevant *z* scores were then calculated using the Fenton preterm growth charts. Following the WHO's convention, low weight-for-age *z* score (WAZ) and low head-circumference-for-age *z* score (HCAZ) were each defined as a score of 2 *SD* or more below the mean (WHO, 1995). Prematurity was defined as birth before 37 completed weeks' gestation. The present analysis included only live births, and infants were included if they had developmental data from the 6 month postpartum visit.

Infant developmental outcomes at age 6 months were assessed with the Bayley Scales of Infant and Toddler Development, Third Edition (Bayley-III; Bayley, 2006a), a tool which has been used globally, including in LMIC settings (Ballot, Potterton, Chirwa, Hilburn, & Cooper, 2012), and which remains an essential measure of infant and toddler developmental milestones. The Bayley III scales were administered by two trained physiotherapists and one registered nurse, with overall supervision by a developmental pediatrician. For our purposes, scaled scores were calculated from captured total raw scores on each Bayley III subtest using the specialized software *Bayley-III Scoring Assistant Update Version 2.0.2 with Bayley-III PDA conduit (BayleyIII_PDA_2_0_2.exe*). These scores represent performance relative to same-age peers. According to the standard guidelines (Bayley, 2006a, 2006b, 2006c), infants scoring ≥ 1 *SD* below the mean of 10 (i.e., scoring ≤ 7) in at least one subtest were classified as manifesting a clinically significant developmental delay in that scale.

Statistical Analysis

All data were analyzed using Stata 12 (StataCorp Inc, College Station, Texas, USA). Frequency distributions and medians (interquartile ranges) were used to describe sociodemographic variables of interest (maternal age, marital status, education, employment, income); childhood and adult trauma exposure and stressful life events; PTSD, depression and psychological distress; alcohol and substance use; birth and 6-month anthropometry; and infant developmental outcomes. Among trauma-exposed mothers, crude associations between maternal PTSD and infant development at age 6 months were explored using two-sample *t* tests and Wilcoxon's rank sum tests (Mann-Whitney tests) for normally and non-normally distributed outcome variables, respectively, where the outcome of interest was scaled scores on each subtest of the Bayley III. In cases where PTSD was significantly associated with scaled scores on the Bayley III subtests in bivariate analysis (at $p<0.05$), linear regression models were used to explore the associations between maternal PTSD, potential confounders, and infant developmental outcomes. These models were adjusted for recruitment site, maternal education, intimate partner violence, maternal alcohol use, and infant anthropometry. Given that no mothers in the TC Newman sample were infected with HIV, maternal HIV-status was not adjusted for in these models due to concerns around collinearity. Likelihood ratio tests were used to assess model fit. These analyses were restricted to trauma-exposed mothers in order to parse out the effects of PTSD itself on infant development.

Results

Maternal Sociodemographic Characteristics

The median (interquartile range [IQR]) age of mothers at enrolment was approximately 25 (22; 31) years, Table 1. Most (62%) were unmarried, and almost a third (32%) was primigravid. The prevalence of maternal HIV infection was 19%. Despite most participants (62%) having completed some secondary education, unemployment in this study sample was highly prevalent (84%). The vast majority (88%) reported a household income of less than R5000 (approximately $500 USD) per month.

Psychosocial Risk Factors

More than a quarter of the study sample scored above threshold on the self-report measures of depression (Beck Depression Inventory: 29%; Edinburgh Postnatal Depression Rating Scale: 26%), Table 1. These findings were supported by the clinician-administered psychiatric assessment (MINI), in which 20% of the study sample was found to have experienced a major depressive episode in their lifetimes, with 5% experiencing a current major depressive episode at the time of assessment. Approximately a quarter (24%) reported experiencing psychological distress (as measured by the SRQ-20), despite a relatively low median (IQR) score (1 [0; 3]) on the measure of past-year stressful life events. Tobacco and alcohol use was prevalent in this study sample, with 41% reporting lifetime use of each of these substances. Further, almost a third (30%) of study participants reported tobacco use during pregnancy, with 8% reporting alcohol consumption during this period. Clinician-administered assessment yielded a sample prevalence of 13% for lifetime alcohol abuse or dependence.

Trauma Exposure and PTSD

Approximately a third (30%) of the study sample reported exposure to trauma during childhood, with half having been exposed to IPV during their lifetimes, Table 1. Further, more than a third (35%) had experienced IPV during the past year. The majority (72%) of this study sample reported exposure to at least one traumatic event (as defined by the *DSM-5*) in their lifetimes (including, but not limited to, childhood trauma and IPV). The overall lifetime prevalence of PTSD was 20%.

Infant Outcomes

Anthropometry—The median (IQR) gestational age at delivery for infants in this study sample was 39 (38; 40) weeks, Table 2. Fourteen percent of infants were born preterm, 8% had decreased WAZ scores at birth and 15% had reduced HCAZ scores at birth. At age 6 months, the prevalence of decreased WAZ scores in this study sample was 7%, and 2% were found to have reduced HCAZ scores.

Infant Development at age 6 months—The median scaled scores for each site, and for the total study sample fell within the normal range across all Bayley III subtests (ie. no median scores ≥ 1 *SD* below the standardised mean of 10; Table 3). However, the prevalence of poor infant developmental outcome as demonstrated by dichotomized scaled scores was notable and ranged from 0.9% (adaptive behavior – communication) to 26% (expressive communication and adaptive behavior – self-direction). Overall, 69% of infants in the study sample exhibited poor developmental outcomes on at least one of the Bayley III subtests.

Association between maternal PTSD and infant developmental outcomes at age 6 months

In crude analyses restricted to trauma-exposed mothers ($N = 81$), maternal PTSD was found to be significantly associated with poorer infant developmental outcomes in the fine motor and adaptive behavior – motor subscales, as measured by a reduction in the median scaled scores. Infants of mothers with PTSD were found to score 1.8 units (95% confidence interval [CI] [0.4, 3.3]) lower on average on the fine motor subscale ($p = 0.015$) and 1.5 units

(95% CI [0.5, 2.4] lower on average on the adaptive behaviour – motor subscale ($p = 0.004$), Table 4, compared to infants of mothers with trauma exposure but no PTSD.

While the association between maternal PTSD and poor fine motor outcomes was no longer significant when adjusted for study site and maternal education, maternal PTSD remained significantly associated with poorer outcomes in the adaptive behavior – motor subscale when adjusted for study site, alcohol dependence, and infant HCAZ at birth. Infants of mothers with PTSD scored, on average, 1.3 units (95% CI [0.4, 2.3]) lower on the adaptive behavior – motor subscale compared to infants of mothers without PTSD, independent of study site, alcohol dependence, and infant HCAZ at birth.

Discussion

In this study of mother-infant data from the DCHS, maternal PTSD was found to be significantly associated with poorer infant developmental outcomes in the fine motor and adaptive behavior – motor subscales (crude analyses); the latter association remained significant when adjusted for study site, alcohol dependence, and infant HCAZ at birth.

While one small-scale study reported recently that exposure to maternal PTSD may be associated with emotion regulation difficulties in infancy (Bosquet Enlow et al., 2011); to the best of our knowledge, ours is the first to investigate specifically the association between maternal PTSD and infant neurodevelopment in a LMIC setting. Our findings are, however, consistent with a growing body of work on the detrimental effect of maternal anxiety on infant and child neurodevelopment. For example, in their prospective study of 170 mother-infant dyads, Huizink, Robles de Medina, Mulder, Visser, and Buitelaar (2003) reported that higher levels of maternal pregnancy-specific anxiety predicted lower mental and motor developmental scores at infant age 6 months. Similarly, in their investigation of 105 Caucasian mother-infant dyads, Brouwers, van Baarb, and Pop (2001) found that high maternal anxiety during late pregnancy was associated with lower mental developmental scores on the Bayley Scales of Infant Development at age 2 years. More recently, Hadley, Tegegn, Tessema, Asefa, and Galea (2008) have reported that maternal symptoms of common mental disorders (including anxiety and depression) were significantly associated with poorer motor, language and social development of 431 infants aged 3 to 24 months in a rural Ethiopian setting. Several different mechanisms for such an association between maternal stress/anxiety and deficits in infant neurodevelopment have been proposed, including hyperactivity of the hypothalamic-pituitary-adrenal axis, with resultant hypercortisolism in both the mother and the infant (Glover, O'Connor, & O'Donnell, 2010; Talge et al., 2007; Van den Bergh, Mulder, Mennes, & Glover, 2005). Epigenetic modifications via glucocorticoid receptor methylation ("silencing") in children exposed to maternal trauma, stress and anxiety (Radtke et al., 2011; Stein et al., 2014), as well as behavioral components associated with maternal PTSD such as hypervigilance or readily distracted attention (Talge et al., 2007) may also contribute to impaired infant neurodevelopment.

A number of key limitations should be borne in mind when considering our study findings. First, our study sample was relatively small, thus reducing the power to detect potentially

significant associations such as those between maternal exposure to psychological trauma and infant developmental outcomes. Second, data on certain psychosocial risk factors (including psychological distress and alcohol/tobacco use) were obtained from self-report assessment tools, which may have biased these findings. Finally, potential moderators and mediators in the relationship between maternal PTSD and infant neurodevelopment (such as partner support and parenting style) were not included in this analysis.

Despite these limitations, our study has allowed one of the first tests of the association between maternal PTSD and poor infant neurodevelopmental outcomes, and the first in a LMIC context. A focus on infant and child development is particularly relevant in LMIC settings. Two recent reviews of data from developing countries (Grantham-McGregor et al., 2007; Walker et al., 2007, 2011; Engle et al., 2007, 2011; Lake, 2011) emphasized that more than 200 million children under the age of five years do not reach their cognitive developmental potential in this context. Given the high prevalence of exposure to trauma and PTSD in pregnant women, our data may be important for informing culturally-appropriate health promotion, screening and intervention campaigns.

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Declaration of Interest

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Table 1

Maternal Demographic and Psychosocial Characteristics, Trauma Exposure and Posttraumatic Stress Disorder (PTSD)

Variable	Total – *n* (%)	Mbekweni – *n* (%)	TC Newman – *n* (%)	*P*-value
Number of mothers	111	56 (50)	55 (50)	
DEMOGRAPHIC AND PSYCHOSOCIAL CHARACTERISTICS				
Self-reported demographic and psychosocial characteristics (antenatal study visit)				
Ethnicity				
Black/African	55 (50)	55 (98)	0 (0)	
Mixed race	56 (50)	1 (2)	55 (100)	<0.001
Age at enrolment, median (IQR)	24.9 (21.7 to 30.6)	27.4 (21.9 to 31.6)	24.0 (21.7 to 27.5)	0.065
Married/Cohabiting	42 (38)	19 (34)	23 (42)	0.391
Educational achievement				
Primary education	8 (7)	6 (11)	2 (4)	
Some secondary education	69 (62)	35 (63)	34 (62)	
Completed secondary education	29 (26)	11 (20)	18 (33)	
Tertiary education	5 (5)	4 (7)	1 (2)	0.163
Employed	18 (16)	6 (11)	12 (22)	0.113
Average household income				
<R1000/month	59 (53)	31 (55)	28 (51)	
R1000-R5000/month	39 (35)	22 (39)	17 (31)	
>R5000/month	13 (12)	3 (5)	10 (18)	0.113
SES quartile				
Lowest SES	43 (39)	28 (50)	15 (27)	
Low-moderate SES	29 (26)	11 (20)	18 (33)	
Moderate-high SES	21 (19)	12 (21)	9 (16)	
Highest SES	18 (16)	5 (9)	13 (24)	0.023
Primagravida	35 (32)	14 (25)	21 (38)	0.135
HIV-infected	21 (19)	21 (38)	0 (0)	<0.001
Median recent life events experienced (IQR)	1 (0 to 3)	1 (0 to 1.5)	2 (1 to 5)	<0.001
Lifetime tobacco use	45 (41)	7 (13)	38 (69)	<0.001
Antenatal tobacco use	33 (30)	2 (4)	31 (56)	<0.001
Lifetime alcohol use	46 (41)	8 (14)	38 (69)	<0.001
Antenatal alcohol use	9 (8)	2 (4)	7 (13)	0.094
Antenatal depression (BDI), above threshold	32 (29)	16 (29)	16 (29)	0.952
Antenatal depression (EPDS), above threshold	29 (26)	15 (27)	14 (25)	0.873
Antenatal psychological distress (SRQ), above threshold	27 (24)	11 (20)	16 (29)	0.246
MINI-diagnosed disorders (6 month postpartum study visit)				
Major depressive episode (lifetime)	22 (20)	9 (16)	13 (24)	0.317
Major depressive episode (current)	5 (5)	1 (2)	4 (7)	0.206
Alcohol dependence/abuse	14 (13)	5 (9)	9 (16)	0.267
TRAUMA EXPOSURE & PTSD				

Variable	Total – *n* (%)	Mbekweni – *n* (%)	TC Newman – *n* (%)	*P*-value
Self-reported trauma exposure (antenatal study visit)				
Childhood trauma, above threshold	33 (30)	13 (23)	20 (36)	0.130
Any lifetime intimate partner violence	55 (50)	21 (38)	34 (62)	0.010
Any recent intimate partner violence	39 (35)	14 (25)	25 (45)	0.024
MINI-diagnosed disorders (6 month postpartum study visit)				
Trauma exposure	80 (72)	41 (73)	39 (71)	0.787
PTSD	22 (20)	9 (16)	13 (24)	0.317

Table 2

Infant Anthropometry at Birth and at 6 Months of Age

Variable[1]	Total – *n* (%)	Mbekweni – *n* (%)	TC Newman – *n* (%)	*P*-value
Number of infants; sets of twins	112	57 (51); 1	55 (49); 0	
Gender, female	58 (52)	34 (60)	24 (44)	0.090
Median gestational age at delivery (IQR)	39 (38 to 40)	39 (38 to 40)	39 (38 to 40)	0.943
Preterm birth	16 (14)	7 (12)	9 (16)	0.537
Infant anthropometry at birth				
Median weight in kg (IQR)	3.0 (2.7 to 3.4)	3.1 (2.8 to 3.3)	3.0 (2.6 to 3.5)	0.463
Median WAZ (IQR)	−0.7 (−1.4 to 0.03)	−0.7 (−1.3 to 0.1)	−0.9 (−1.5 to −0.01)	0.270
Low WAZ (WAZ of −2 or below)	9 (8)	3 (5)	6 (11)	0.317
Median head circumference in cm (IQR)	34 (32 to 34)	33 (32 to 34)	34 (32 to 34)	0.894
Median HCAZ (IQR)	−0.6 (−1.5 to 0.1)	−0.6 (−1.4 to 0.1)	−0.6 (−1.6 to 0.2)	0.907
Low HCAZ (HCAZ of −2 or below)	17 (15)	7 (12)	10 (18)	0.384
Infant anthropometry at 6 months of age				
Median age in months at study visit (IQR), corrected for prematurity at birth	5.9 (5.8 to 6.0)	5.9 (5.9 to 6.0)	5.9 (5.8 to 6.0)	0.773
Median weight in kg (IQR)	7.8 (6.7 to 8.6)	8.1 (7.1 to 8.8)	7.4 (6.5 to 8.5)	0.051
Median WAZ (IQR)	0.2 (−0.8 to 1.0)	0.4 (−0.4 to 1.4)	−0.1 (−1.0 to 0.8)	0.011
Low WAZ (WAZ of −2 or below)	8 (7)	1 (2)	7 (13)	0.030
Median change in WAZ between birth and 6 months (IQR)	0.8 (−0.2 to 1.5)	1.0 (−0.02 to 1.9)	0.6 (−0.4 to 1.2)	0.076
Median head circumference in cm (IQR)	43 (42 to 44.3)	43 (42 to 44.5)	43 (42 to 44)	0.815
Median HCAZ (IQR)	0.2 (−0.6 to 1.4)	0.2 (−0.6 to 1.8)	−0.01 (−0.7 to 1.3)	0.400
Low HCAZ (HCAZ of −2 or below)	2 (2)	2 (4)	0 (0)	0.496
Median change in HCAZ between birth and 6 months (IQR)	1.1 (−0.1 to 2.1)	1.3 (−0.04 to 2.5)	1.0 (−0.1 to 1.8)	0.375

[1] WAZ = Weight-for-age *z* score; HCAZ = Head circumference-for-age *z* score

Table 3

Infant Neurodevelopmental Outcomes at 6 Months of Age

Variable	Total – *n* (%)	Mbekweni – *n* (%)	TC Newman – *n* (%)	*P*-value
Number of infants; sets of twins	112	57 (51); 1	55 (49); 0	
Median age in months at study visit (IQR), corrected for prematurity at birth	6.0 (5.7 to 6.2)	6.0 (5.8 to 6.2)	5.9 (5.7 to 6.3)	0.397
Cognitive scale				
Median score (IQR)	10 (8 to 12)	11 (8 to 12)	10 (8 to 11)	0.944
Poor cognitive outcomes	22 (20)	13 (23)	9 (16)	0.391
Communication scale				
Receptive communication, median score (IQR)	11 (8 to 12)	10 (9 to 12)	11 (8 to 12)	0.788
Poor receptive communication outcomes	25 (22)	13 (23)	12 (22)	0.900
Expressive communication, median score (IQR)	11 (7 to 13.5)	11 (9 to 14)	10 (7 to 13)	0.258
Poor expressive communication outcomes	29 (26)	13 (23)	16 (29)	0.448
Motor scale				
Fine motor, median score (IQR)	13 (12 to 15)	13 (12 to 15)	13 (11 to 15)	0.404
Poor fine motor outcomes	5 (4)	2 (4)	3 (5)	0.676
Gross motor, median score (IQR)	11 (8 to 12)	11 (9 to 12)	11 (8 to 13)	0.600
Poor gross motor outcomes	12 (11)	4 (7)	8 (15)	0.234
Social-emotional scale				
Median score (IQR)	13 (11 to 15)	13 (11 to 15)	14 (11 to 16)	0.218
Poor social-emotional outcomes	8 (7)	1 (2)	7 (13)	0.030
Adaptive behavior scale				
Communication, median score (IQR)	11 (10 to 12)	11 (9 to 12)	11 (10 to 12)	0.516
Poor communication outcomes	1 (0.9)	0 (0)	1 (2)	0.491
Health and safety, median score (IQR)	10 (9 to 10)	10 (9 to 10)	10 (10 to 10)	0.126
Poor health and safety outcomes	4 (4)	3 (5)	1 (2)	0.618
Leisure, median score (IQR)	11 (9 to 12)	10 (9 to 12)	11 (10 to 13)	0.056
Poor leisure outcomes	10 (9)	4 (7)	6 (11)	0.524
Self-care, median score (IQR)	11 (10 to 12)	10 (9 to 12)	11 (10 to 12)	0.256
Poor self-care outcomes	7 (6)	4 (7)	3 (5)	1.000
Self-direction, median score (IQR)	10 (7 to 11)	10 (7 to 11)	10 (7 to 12)	0.272
Poor self-direction outcomes	29 (26)	15 (26)	14 (25)	0.917
Social, median score (IQR)	12 (11 to 13)	11 (11 to 12)	12 (11 to 13)	0.016
Poor social outcomes	2 (2)	2 (4)	0 (0)	0.496
Motor, median score (IQR)	11 (10 to 12)	11 (10 to 12)	11 (10 to 12)	0.685
Poor motor outcomes	12 (11)	5 (9)	7 (13)	0.554
Any poor developmental outcome across all scales	77 (69)	40 (70)	37 (67)	0.740

Table 4

Adjusted Associations Between Maternal Posttraumatic Stress Disorder (PTSD) and Infant Fine Motor Outcomes and Infant Adaptive Behavior – Motor Outcomes at 6 Months of Age, Restricted to Trauma-Exposed Mothers (n = 81)

	Adjusted associations between maternal PTSD and infant fine motor outcomes				Adjusted associations between maternal PTSD and infant adaptive behavior – motor outcomes			
Variable	**Crude regression coefficient [95% CI]**	***P*-value**	**Adjusted regression coefficient [95% CI]**	***P*-value**	**Crude regression coefficient [95% CI]**	***P*-value**	**Adjusted regression coefficient [95% CI]**	***P*-value**
Recruitment site								
Mbekweni	Reference		Reference		Reference		Reference	
TC Newman	−0.3 (−1.6 to 1.1)	0.684	−0.1 (−1.5 to 1.2)	0.848	0.01 (−0.9 to 0.9)	0.990	0.2 (−0.6 to 1.1)	0.599
Maternal educational achievement								
Tertiary education	Reference		Reference		Reference			
Completed secondary education	−2.9 (−6.6 to 0.8)	0.119	−2.3 (−6.1 to 1.4)	0.216	−1.0 (−3.5 to 1.6)	0.460		
Some secondary education	−2.2 (−5.7 to 1.3)	0.222	−1.8 (−5.3 to 1.8)	0.327	−1.0 (−3.4 to 1.5)	0.437		
Primary education	−5.7 (−10.5 to −0.8)	0.023	−4.7 (−9.6 to 0.2)	0.061	−1.0 (−4.4 to 2.4)	0.558		
Lifetime IPV exposure								
Below threshold	Reference				Reference			
Above threshold	0.1 (−1.3 to 1.4)	0.936			−1.1 (−2.0 to −0.3)	0.012		
Recent IPV exposure (antenatal)								
Below threshold	Reference				Reference			
Above threshold	−1.0 (−2.5 to 0.4)	0.152			−1.7 (−2.6 to −0.8)	<0.001		
Antenatal alcohol use								
No self-reported alcohol use	Reference				Reference			
Self-reported alcohol use	−1.2 (−3.7 to 1.4)	0.371			−2.1 (−3.7 to −0.4)	0.017		
MINI-diagnosed alcohol dependence/abuse								
No alcohol dependence/abuse	Reference				Reference		Reference	
Alcohol dependence/abuse	−0.3 (−2.3 to 1.7)	0.775			−1.4 (−2.7 to −0.1)	0.036	−1.3 (−2.5 to −0.1)	0.035
Infant WAZ at birth	0.5 (−0.2 to 1.1)	0.152			0.5 (0.03 to 0.9)	0.038		
Infant WAZ at 6 months	−0.1 (−0.6 to 0.4)	0.719			0.2 (−0.2 to 0.5)	0.401		
Change in infant WAZ between birth and 6 months	−0.4 (−0.9 to 0.1)	0.153			−0.1 (−0.5 to 0.2)	0.449		

	Adjusted associations between maternal PTSD and infant fine motor outcomes				Adjusted associations between maternal PTSD and infant adaptive behavior – motor outcomes			
Variable	**Crude regression coefficient [95% CI]**	***P*-value**	**Adjusted regression coefficient [95% CI]**	***P*-value**	**Crude regression coefficient [95% CI]**	***P*-value**	**Adjusted regression coefficient [95% CI]**	***P*-value**
Infant HCAZ at birth	0.3 (−0.3 to 1.0)	0.295			0.5 (0.1 to 0.9)	0.010	0.4 (0.03 to 0.8)	0.033
Infant HCAZ at 6 months	0.3 (−0.2 to 0.8)	0.217			0.2 (−0.1 to 0.5)	0.285		
Change in infant HCAZ between birth and 6 months	0.1 (−0.4 to 0.5)	0.692			−0.1 (−0.4 to 0.2)	0.407		
PTSD diagnosis								
No PTSD	Reference		Reference		Reference		Reference	
Lifetime/Current PTSD	−1.8 (−3.3 to −0.4)	0.015	−1.5 (−3.0 to 0.1)	0.060	−1.5 (−2.4 to −0.5)	0.004	−1.3 (−2.3 to −0.4)	0.007