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Post-traumatic stress disorder, child abuse history, birthweight and gestational age: a prospective cohort study

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Objective To determine the extent to which prenatal post-traumatic stress disorder (PTSD) is associated with lower birthweight and shorter gestation, and to explore the effects of childhood maltreatment as the antecedent trauma exposure.

Design Prospective three-cohort study.

Setting Ann Arbor and Detroit, Michigan, United States.

Sample In all, 839 diverse nulliparas in PTSD-positive (n = 255), trauma-exposed, resilient (n = 307) and non-exposed to trauma (n = 277) cohorts.

Methods Standardised telephone interview before 28 weeks of gestation to ascertain trauma history, PTSD, depression, substance use, mental health treatment history and sociodemographics, with chart abstraction to obtain chronic condition history, antepartum complications and prenatal care data, as well as outcomes.

Main outcome measures Infant birthweight and gestational age per delivery record.

Results Infants born to women with PTSD during pregnancy had a mean birthweight 283 g less than infants of trauma-exposed, resilient women and 221 g less than infants of non-exposed women ($F_{3,835}$ = 5.4, P = 0.001). PTSD was also associated with shorter gestation in multivariate models that took childhood abuse history into account. Stratified models indicated that PTSD subsequent to child abuse trauma exposure was most strongly associated with adverse outcomes. PTSD was a stronger predictor than African American race of shorter gestation and a nearly equal predictor of birthweight. Prenatal care was not associated with better outcomes among women abused in childhood.

Conclusions Abuse-related PTSD may be an additional or alternative explanation for adverse perinatal outcomes associated with low socio-economic status and African American race in the USA. Biological and interventions research is warranted along with replication studies in other nations.

Keywords Abuse, birthweight, childhood maltreatment, gestational age, health disparities, perinatal outcomes, post-traumatic, stress disorder.

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Introduction

Post-traumatic stress disorder (PTSD) is prevalent among women; occurring in the aftermath of traumatic events like war, disaster, childhood maltreatment, rape and battering.[1–4] Studies with women who are pregnant find prevalence rates near 8% and greatest risk associated with history of abuse trauma (odds ratio 12, 95% CI 4–40).[5] Women with low socio-demographic status tend to have higher rates of PTSD in pregnancy, as do African American women.[6] PTSD might be an additional risk factor for preterm birth and low birthweight among these vulnerable groups.

Evidence continues to accumulate to underscore the importance of addressing preterm birth and the combined low birthweight associated with it. A recent cost analysis conducted on the State of Michigan and US national data found that preterm birth is the leading cause of health problems in infants and is estimated to cost the USA more than $26 billion annually.[7] This same report found that an

African American infant in Michigan is 70% more likely to be born prematurely than an infant of any other race. A recent epidemiological study of cognitive and socio-emotional outcomes followed babies to 6 years of age from Detroit, the largest city in the state of Michigan, and found that even those babies born 'late' preterm (at 34–36 weeks of gestation) had a greater risk of clinically significant impairments after controlling for many potential prenatal and childhood confounding factors.[8] Hence, a finding that PTSD—a treatable condition occurring at greater rates in pregnancy among African Americans[6]—is associated with shorter gestation would suggest new avenues for improving perinatal outcomes in high-risk populations.

There have been nine studies (see Table S1a,b)[9–17] assessing the relationship of prenatal PTSD to birthweight and gestational age. They share a common underlying assumption that PTSD could adversely affect both fetal growth and timing of parturition secondary to stress pathophysiology. These studies have several shortcomings, most importantly small samples of limited diversity and lack of trauma-exposed and non-exposed comparison groups. They have not considered potential differences, in terms of biological and psychological impact, associated with type or timing of trauma exposure (e.g. interpersonal violence in childhood versus experiencing a disaster as an adult).[18–21] Few examined co-occurring risk behaviours or known co-morbidities of PTSD.[22] This study addressed several limitations of these previous studies and considered the effects of the trauma exposure of childhood abuse in stratified models to provide a better basis for inferences about the effects of PTSD on perinatal outcomes.

Methods

Design

This is a prospective three-cohort study (NIH NR008767, PI Seng). Its primary aim is to determine the extent to which PTSD is associated with adverse outcomes during the childbearing year, including obstetric, mental health and bonding outcomes. This paper reports on the perinatal outcomes of gestational age and birthweight.

Organising framework

The relationships between trauma exposure, PTSD and health outcomes are influenced by numerous factors. Consideration of these factors such as socio demographic risk, co-occurring mental health conditions and health risk behaviours must then be taken into account in statistical analyses when exploring the risks of PTSD on childbearing outcomes.[23] In this study a framework was used consistent with research recommendations proposed by the US Centers for Disease Control and Prevention for research on violence occurring around the time of pregnancy.[24]

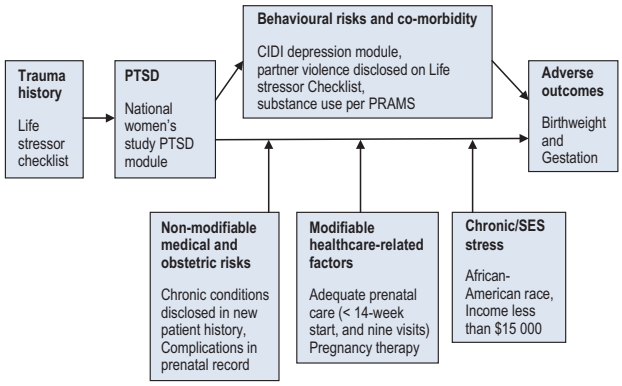

Figure 1. Diagram of conceptual framework organising the statistical modelling with measures used.

Figure 1 depicts the components included in this study's models (in bold font) and the measures used to create the variables in the statistical models. In brief, the core proposition is that trauma exposure is associated with adverse outcomes via PTSD. In turn, PTSD may be associated with adverse outcomes via risk behaviours and co-morbidity. The strength of this association could be influenced by three broad sets of factors: nonmodifiable medical and obstetric risks, modifiable healthcare-related factors and chronic stress such as that related to sociodemographic status.[24]

Recruitment

Recruitment and follow up took place from August 2005 to March 2008 using the prenatal clinics of three large health systems in the State of Michigan. Institutional Review Board approval was obtained from all three entities, and a Confidentiality Certificate was obtained. Details of recruitment, including a flow diagram, have been published elsewhere[5] but are summarised here. Half the sample came from urban clinics that served primarily minority and poor women. To maintain generalisability of the study results to diverse women, and because poor and African American women have the worst perinatal outcomes in the USA, we over-sampled from these settings to allow for the greater attrition that occurs among disadvantaged groups. Eligible women were expecting their first infant, 18 years or older, able to speak English without an interpreter, and had initiated prenatal care before 28 weeks of gestation. Nurses invited eligible women to take part in a survey study of 'stressful things that happen to women, emotions and pregnancy'. Interested women gave contact information, were provided with an information document with the elements of informed consent, and were then contacted by a professional health research survey organisation (DataStat, Ann Arbor, MI, USA), where verbal consent took place, eligibility was confirmed, and a standardised psychiatric diagnostic

interview was conducted using computer-assisted telephone interview technology. Participants were reimbursed $20 by cheque for the completed interview. The initial sample required that 1581 women be enrolled to follow up a target sample size with the power to study conditions occurring in as few as 2% of women (e.g. hyperemesis).

Sample

The computer-assisted telephone interview scoring algorithm assigned these interview completers to one of four cohorts: non-exposed to trauma controls ($n = 350$), trauma-exposed, resilient (PTSD-negative) controls ($n = 380$), and PTSD-positive women ($n = 319$). The fourth cohort included women who did not match one of these definitions ($n = 532$), and these women were dismissed from follow up. Women assigned to one of the three follow-up cohorts at the end of the interview were invited to continue in the study and provided additional informed consent for medical records review after delivery and follow-up interviews. The three-cohort design is common in PTSD research where the trauma exposure itself is an alternative or additive explanation for outcomes associated with PTSD.[25] We divided the PTSD-positive cohort for most analyses into those who had recovered and those who were still affected at the time of the interview. For this report we only include women who had prenatal and delivery medical records and live singleton births ($n = 839$). Figure 2 depicts the definition of the cohorts and composition specific to this report.

Medical records abstraction

Two sites used paper charts, and a labour and delivery nurse abstracted details onto a paper form. Reliability was established early in the project by training, creating decision tools and revising the form until inter-rater agreement reached 92.7%.[26] A 5% audit over the life of the project resulted in 94.4% agreement, which is considered excellent reliability.[27] Data were double entered from the paper forms. The third site used an electronic medical record. A list of items, developed by investigators and data managers, were extracted, downloaded and transformed to a flat spreadsheet for cleaning and recoding in SPSS (SPSS Inc., Chicago, IL, USA). Manual reading of individual patient electronic medical records was performed to redress errors in original data entries, such as data missing by being entered in the wrong field.

Measures and variable construction

Whenever possible, established measures were used in the survey interviews. Psychometrics and scoring procedures for measures from the initial psychiatric diagnostic interview have been reported earlier.[5] Instruments and variable definitions are listed in the Table S2.[28–32] The adverse outcomes of childbearing we focused on for this report were gestational age and birthweight, both as interval-level variables and as adverse outcomes. These were defined as preterm (<37 completed weeks of gestation), and low birth weight (<2500 g).

Analysis plan

We began by accounting for the attrition from the initial interview as a result of multiple gestation and losses, as well as because of not being able to obtain a record. We also verified that the relationships between PTSD and outcome variables met the assumption of linearity before regression modelling. To do this, we tested the hypothesis that PTSD is associated with gestational age and birthweight outcomes via chi-square and analysis of variance comparisons across the three cohorts, splitting the PTSD-positive group into lifetime-positive, recovered women (PTSD-recovered) and currently positive, affected women

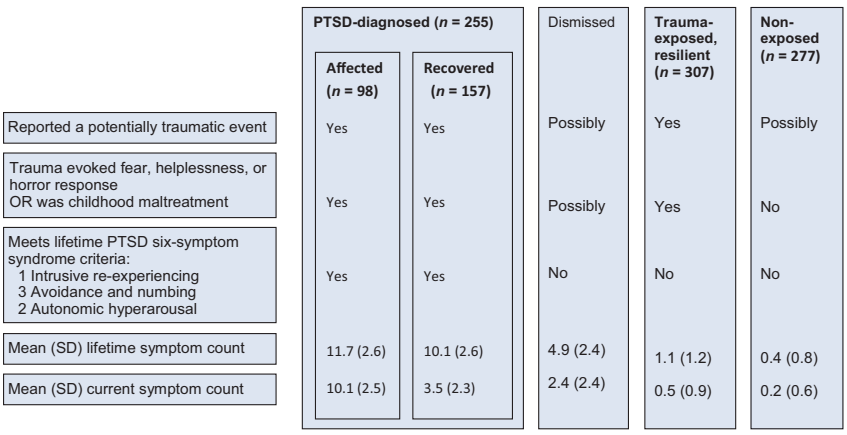

Figure 2. Cohort definitions. Per Scheffe *post hoc* tests all groups differ significantly for lifetime symptom counts. For current symptom counts, the trauma-exposed, resilient and non-exposed cohorts do not differ.

(PTSD-affected). We then considered the full complexity of the potentially mediating or moderating factors with stepwise linear regression models based on the conceptual framework presented, for both outcomes, birthweight and gestational age. This first set of models involved the whole sample. Then we divided the sample into groups with ($n = 174$) and without ($n = 665$) child abuse history to consider how patterns may have differed based on trauma type.

Results

The sample size included in this analysis was 839 women for whom we had complete prenatal and obstetric record data that included the necessary variables in this analysis (birthweight, gestational age, prenatal care information, and pre-pregnancy medical history) and who were known not to have experienced miscarriage ($n = 33$) or elective termination of pregnancy ($n = 4$) subsequent to the screening interview, nor multiple gestation ($n = 12$), fetal demise, stillbirth or neonatal death ($n = 7$). Prevalence of these reasons for exclusion did not differ significantly across the three cohorts. Within this sample, there were 255 PTSD-positive women, 277 in the non-exposed cohort, and 307 in the trauma-exposed, resilient cohort. Within the PTSD-positive cohort, 98 had current PTSD (affected) and 157 had had PTSD previously (recovered). Chi-square comparisons of the 839 women with medical records data and live singleton births and the 1049 women who were assigned to follow up based on the first interview indicated that they did not differ in the proportion in each cohort ($\chi^2_2 = 072$, $P = 0.964$) or in the proportion who were sociodemographically disadvantaged ($\chi^2_1 = 0.066$, $P = 0.798$).

Extensive descriptive data on the sample as a whole and comparisons across the four cohorts are depicted in Table 1. The PTSD-affected cohort had more sociodemographic risk factors, more childhood abuse, more substance use, more recent intimate partner violence, and a lower rate of adequate prenatal care than the other cohorts. The PTSD-affected and PTSD-recovered cohorts had similar rates of major depression in the past year and of pregnancy mental health treatment. The trauma-exposed, resilient cohort had the fewest sociodemographic disadvantages, lower rates of childhood abuse trauma, a low rate of depression, low levels

Table 1. Descriptions of the sample overall and by cohort, depicting all factors included in the multivariate models

	Total $n = 839$	PTSD-affected 11.8% ($n = 98$)	PTSD-recovered 18.7% ($n = 157$)	Non-trauma exposed 36.6% ($n = 277$)	Trauma-exposed, resilient 33.4% ($n = 307$)	Chi-square	*P*
Sociodemographic risk factors % (*n*)							
African-American	41.4 (347)	74.5 (73)	40.1 (63)	41.9 (116)	30.9 (95)	58.2	< 0.001
Poverty (income <$15,000)	22.1 (185)	44.9 (44)	23.6 (37)	19.5 (54)	16.3 (50)	37.6	<0.001
Low education (≤high school)	44.5 (373)	76.5 (75)	41.4 (65)	48.4 (134)	32.2 (99)	61.7	<0.001
Pregnant as a teen	21.1 (179)	36.7 (36)	18.5 (29)	24.5 (68)	15.0 (46)	23.7	<0.001
High crime zip code (>US average)	37.3 (313)	67.3 (66)	35.0 (55)	40.1 (111)	26.4 (81)	54.7	<0.001
Trauma history factors % (*n*)							
Child abuse (before age 16)	20.7 (174)	56.1 (55)	40.8 (64)	1.8 (5)*	16.3 (50)	177.1	<0.001
Past-only (not recent) adult abuse	8.4 (74)	20.4 (20)	15.3 (24)	1.4 (4)*	8.5 (26)	43.3	<0.001
Event was index trauma**	10.7 (90)	6.1 (6)	16.6 (26)	4.0 (11)*	15.3 (47)	27.7	<0.001
Mental health and risk exposure % (*n*)							
Major depression in past year	12.0 (101	29.6 (29)	29.3 (46)	4.0 (11)	4.9 (15)	104.5	<0.001
Any substance use in pregnancy	25.7 (216)	48.0 (47)	32.5 (51)	19.1 (53)	21.2 (65)	38.7	<0.001
Past year partner violence	3.2 (27)	13.3 (13)	5.7 (9)	1.1 (3)	0.7 (2)	45.5	<0.001
Medical/obstetric risk factors % (*n*)							
Pre-existing chronic condition	43.6 (366)	31.6 (31)	54.1 (85)	39.0 (108)	46.3 (142)	16.1	<0.001
Antepartum problem	23.8 (200)	18.4 (18)	24.2 (38)	26.7 (74)	22.8 (70)	3.1	0.381
Healthcare-related factors % (*n*)							
Adequate prenatal care	64.1 (538)	46.9 (46)	65.6 (103)	62.8 (174)	70.0 (215)	17.6	0.001
Past therapy or medication	31.5 (264)	42.9 (42)	61.1 (96)	14.4 (40)	28.0 (86)	109.0	<0.001
Pregnancy therapy or medication	5.6 (47)	14.3 (14)	14.6 (23)	1.8 (5)	1.6 (5)	55.0	<0.001

Degrees of freedom for chi-square, 3.

*Non-exposed women reported some exposures but none meeting DSM-IV criteria. Childhood abuse was a criterion for inclusion in the trauma-exposed cohort if it was physical or sexual abuse; the non-exposed women's childhood abuse was emotional.

**Potentially traumatic events queried were disaster, war, witnessing or being in an accident, being jailed, serious illness, painful procedure or ritual, separation or divorce, witnessing or being attacked or robbed, being sexually harassed.

of substance use and intimate partner violence exposures, and the highest rate of using adequate prenatal care.

We first examined the associations of PTSD symptom count and cohort with the outcomes using bivariate tests. The correlation of current PTSD symptom count with gestational age was not significant ($r = -0.044$, $P = 0.202$). Grouping by cohort to examine gestational age as a continuous variable showed no significant relationship (Table 2). The negative correlation of current PTSD symptom count with birthweight was significant but weak ($r = -0.122$, $P < 0.001$). Looking at birthweight in grams by cohort (Table 2), the PTSD-affected cohort differed substantially from the trauma-exposed resilient cohort). In brief, these bivariate tests showed that current PTSD was not significantly associated with preterm birth and current PTSD was significantly associated with lower birthweight, a difference of 283 g compared with the trauma exposed, resilient cohort and 221 g compared with the non-exposed cohort ($P = 0.001$). To meet the requirement for linearity for regression modelling we therefore used the trauma-exposed, resilient cohort as the reference category.

We next constructed theory-based stepwise linear regression models, with each step adding co-variates according to the organising framework. First we used the entire sample ($n = 839$), so the focus was on the effect of PTSD, taking childhood abuse history into account. We then stratified by childhood abuse history (negative history $n = 665$, positive history $n = 174$) to assess whether the pattern changed based on antecedent trauma type. Table S3 in the online supporting information presents these three models for the birthweight outcome, and Table S4 in the supporting information presents the models for the gestational age outcome.

In relation to birthweight, in the model on the whole sample, having adjusted for childhood abuse trauma exposure, which was not independently predictive, being in the PTSD-affected cohort, and having an antepartum complication increased risk. Having a pre-existing chronic condition and using adequate prenatal care decreased risk. When the African American race and poverty components of chronic stress were added in the sixth step, they weakened the relationship of current PTSD and of the pre-existing chronic condition. Overall this model explained 14.7% of variance in birthweight.

Within the subsample that did not experience childhood abuse ($n = 665$), the pattern was similar to that found in the entire sample, but race and poverty accounted for more risk and weakened the association of current PTSD with birthweight. The amount of overall variance in birthweight explained by the model was smaller, 5.3%.

Among childhood abuse survivors ($n = 174$), the association of current PTSD with lower birthweight was stronger and this factor alone explained 7.9% of variance. The rest of the pattern differed from the overall sample and from the non-abused subsample. Substance use contributed to risk. Adequate prenatal care was not an independently significant protective factor. Poverty was not an independently significant risk factor. Race mediated the association of PTSD. The variance explained within this subset was a larger proportion than for the sample as a whole, 19.2%.

In relation to the gestational age outcome, the pattern was similar for the overall sample to the pattern seen in relation to birthweight, except that neither pre-existing chronic conditions nor poverty were independently signifi-

Table 2. Birthweight and gestational age comparisons by cohorts

Group	Mean	SD	ANOVA	Group	Mean	SD	ANOVA
Birthweight (g)				**Gestational age (weeks)**			
PTSD-affected	3053	682	$F = 5.4$	PTSD-affected	38.7	2.8	$F = 1.3$
PTSD-recovered	3244	521	$df = 3, 835$	PTSD-recovered	39.2	1.8	$df = 3, 835$
Non-exposed	3274	628	$P = 0.001$	Non-exposed	39.1	2.5	$P = 0.269$
Trauma-resilient	3336	612		Trauma-resilient	39.3	2.4	
Overall	3265	615		Overall	39.1	2.4	
Group	%	n	Chi-square	Group	%	*n*	Chi-square
Low birthweight				**Preterm birth**			
PTSD-affected	13.3	13	$\chi^2 = 2.9$	PTSD-affected	22.4	22	$\chi^2 = 7.2$
PTSD-recovered	8.3	13	$df = 3$	PTSD-recovered	12.1	19	$df = 3$
Non-exposed	8.7	24	$P = 0.414$	Non-exposed	17.3	48	$P = 0.067$
Trauma-resilient	7.8	24		Trauma-resilient	13.0	40	
Overall	8.8	74		Overall	15.4	129	

cantly associated. The variance explained within the model on all 839 women was 12.2%.

Within the non-abused subset, PTSD was not at all associated with gestational age. Neither was race or poverty. Only antepartum complications and adequate prenatal care were significant independent predictors in a model that nevertheless explained 13.3% of variance.

Within the childhood abuse subset, current PTSD had a similarly strong predictive value for gestational age as it had for birthweight. Antepartum complications and current PTSD conveyed similar levels of risk. Neither race nor poverty were significant predictors of gestational age after the other factors were taken into account. Intimate partner violence was an independently significant predictor associated with longer gestation ($\beta = 0.167$, $P = 0.031$). *Post hoc* examination of this counterintuitive finding showed that of the 27 women with past-year partner violence, none delivered at <34 weeks of gestation, three were preterm, 18 were term, and six were postdates deliveries. The steps including PTSD, comorbidities and risk behaviours, and the nonmodifiable obstetric risk factor of antepartum complications explained 17.5% of variance, with the adjusting in the modifiable healthcare-related factors step adding another 0.5% and the chronic stress step contributing no additional variance.

We conducted a *post hoc* examination of the correlation of birthweight with gestational age across cohorts and across child abuse strata. Our rationale for this exploration was that gestational age could be associated with birthweight to varying extents within each stratum. The plausible biological mechanisms for low birthweight and for prematurity may be shared or distinct to varying extents based on the mother's psychobiological status. Her psychobiological status would be expected to differ based on factors that distinguish the cohorts and strata, as will be discussed below. The association was not as strong in the stratum abused in childhood ($r = 0.608$, $P < 0.001$) and in the PTSD-positive cohort ($r = 0.699$, $P < 0.001$) compared with the non-abused stratum ($r = 0.760$, $P < 0.001$) and non-exposed cohort ($r = 0.765$, $P < 0.001$).

Discussion

Results of this study redress gaps in the literature regarding PTSD and perinatal outcomes by using a prospective cohort design, recruiting a diverse sample, considering one major antecedent trauma type, and taking numerous theoretically relevant factors into account. Findings show that there is an association between PTSD diagnosis and the adverse outcomes of lower birthweight and shorter gestation and that the effect is strongest among women currently affected with PTSD who are childhood abuse survivors. In the abused subsample, substance use and antepartum complications play a role in lower birthweight. African American race weakens the association of prenatal PTSD with birthweight. Race is not an independent predictor of prematurity among abuse survivors. Adequate prenatal care, which is a protective factor in the overall and non-abused samples, is not protective in relation to either outcome among childhood abuse survivors. The decrement in birthweight for women with current PTSD is 283 g compared with the trauma-exposed, resilient cohort and 221 g compared with the non-exposed cohort. This is a clinically meaningful difference, especially as it co-occurs with the 13.3% low birthweight rate and 22.4% preterm birth rate for this group, suggesting that it could contribute to infant morbidity.

Future research on plausible biological mechanisms for the effects of PTSD on perinatal outcomes should consider that PTSD-related pathophysiology may affect birthweight and gestational length via different mechanisms. Our *post hoc* analysis of the correlation of gestational age with birthweight informs this thinking because the expected high correlation was weakest in the childhood abuse stratum and in the PTSD-positive cohort. For example, women with PTSD from childhood maltreatment could have dysregulation in the oxytocin system stress-response function.[33] This in turn could affect fetal growth via oxytocin's interaction with growth hormones.[34] The duration of gestation could be affected by PTSD-associated hypothalamic–pituitary–adrenal axis dysregulation.[35] This in turn could affect the cervix and chorioamnion by inflammatory and immune system alterations.[35,36] Other investigators have demonstrated that the impact of stress exposure (i.e. the acute trauma of death of a family member during pregnancy) can differentially affect birthweight and gestational outcomes,[37] and that the biological indictors of stress or distress can be better predictors than the psychological factor.[38] The different patterns of factors predicting the two outcomes in this clinical study support the need for future studies of mechanisms to continue to model birthweight and gestational age separately. Conversely, population-based research to replicate these findings on large, representative samples is needed. In these future studies, the public health and economic effects of PTSD in pregnancy can be better estimated on the outcome of small size for gestational age which can then be considered in relation to population standards.

The finding that African American race is only variably involved in the pathway between PTSD and these adverse outcomes also seems important from a clinical and public health perspective. Race has been considered a nearly immutable perinatal risk factor in the USA, but findings from these models suggest that part of the risk may be shared with the treatable condition of PTSD, especially when the PTSD occurs in the aftermath of childhood abuse. Importantly, our analysis of race as a risk factor for PTSD[6] indicated that African American women are at no

greater risk for onset of PTSD, but they have a four-fold greater risk for remaining affected by PTSD at the time of pregnancy. Reasons for this greater risk of PTSD in pregnancy include having had less treatment, and having had more lifetime trauma exposures overall, which may maintain or re-activate PTSD. Moreover, because their average age at pregnancy is younger, less time would have elapsed since the childhood abuse occurred, so there would be less chance for remittance. Young age itself is also a risk factor for PTSD.[39] Disparities in birth outcomes in other nations may also occur based on disadvantaged status (e.g. immigrant versus native born women[40]) and disadvantaged status is probably associated with greater trauma exposure and PTSD in these settings as well.[41] Hence child abuse, gender-based violence, other culturally specific trauma exposures and PTSD status should be incorporated into international perinatal epidemiology studies. A public health framework could therefore be applied to understand lower birthweight and shorter gestation as the tertiary outcomes of failure to implement primary prevention of trauma exposure and secondary prevention of PTSD before pregnancy. Taken together, the findings from this study suggest previously unexamined possibilities to address potentially causative factors for perinatal health disparities.

The finding that prenatal care is not protective for the child abuse survivors is consistent with numerous qualitative[42] and clinical[43–45] papers indicating that abuse survivors, especially those with histories of sexual abuse, avoid or struggle with prenatal care. Avoidance of reminders of their precipitating trauma (i.e. triggers) is a hallmark and diagnostic criterion for PTSD. So women with abuse-related PTSD may come later to prenatal care or skip visits to avoid triggers such as vaginal examinations or caregiver relationship challenges. Alternatively, when women with a trauma history do adhere to the visit schedule, they may experience PTSD exacerbation, undermining the benefits of care by activating biological and behavioural stress responses. Research is warranted to develop maternity care models that address the needs of this substantial population. A 2008 study of 4549 children in the USA found that girls in the 14–17-year age group had a lifetime maltreatment rate of 18.6% (excluding sexual assault by a known adult), and a 13.8% lifetime rate of completed or attempted rape, of which half (7.7%) were by a known adult.[46] In this study's community sample, 31.6% of women who were maltreated before the age of 16 met PTSD criteria during pregnancy, with childhood abuse-related PTSD accounting for 56.1% of those cases occurring during pregnancy ($\chi^2_1 = 84.5$, $P < 0.001$). It is important to determine what benefit there might be to trauma-informed outreach programmes to encourage PTSD-affected women to enter prenatal care earlier. Research is also warranted to develop adapted service delivery models (e.g. continuity to improve trust, referral to obstetricians or midwives interested in psychosomatic care) or enriched models of care such as the use of doulas or outreach workers trained to provide trauma-informed supportive care, which might improve adherence to prenatal care. At the very least, integrating screening and treatment for PTSD into prenatal clinic routines would seem reasonable and a critical first step in addressing the potential risks of PTSD on pregnancy outcomes suggested in this investigation and others. This might only represent an incremental change in service delivery in settings where these structures are already in place to address depression or risk of domestic violence. There are evidence-based psychotherapy and pharmacology treatments for PTSD.[47] Research is warranted to determine their safety and efficacy for pregnant women and to determine whether treating PTSD improves perinatal outcomes. It will be an especially high priority to conduct such research and implement programmes in settings where minority women are served.

Findings of this study differ somewhat from two studies of childhood sexual abuse survivors that found higher rates of preterm birth. Noll and colleagues[48] have followed a Washington, D.C. cohort of girls in child protection services for sexual abuse and a matched comparison group. The rate of preterm birth was 20.6% for the abused group and 10.7% for the comparison group (adjusted odds ratio 2.80, 95% CI ± 1.44, $P < 0.05$). Leeners and colleagues[49] in a retrospective study of 85 mothers in Germany seeking support services for a history of childhood sexual abuse and 170 matched controls found similar rates and odds ratios for preterm birth (18.8% versus 8.2%, odds ratio 2.58, 95% CI 1.19–5.59). By contrast, our modelling did not find childhood maltreatment (defined as physical, emotional or sexual abuse or physical neglect) to be a significant independent predictor of preterm birth, but rather found that PTSD that was subsequent to such trauma exposure was implicated instead. *Post hoc* chi-square tests in our data verified that childhood sexual abuse specifically had no significant association with preterm birth. Neither the Noll et al. nor the Leeners et al. study measured PTSD as a possible mediator of the preterm birth outcome. However, adults whose sexual abuse had resulted in their being identified for child protection services and adults seeking mental health support services for sexual abuse may well have been affected by PTSD that was unmeasured.

Limitations to this study are those inherent to survey research. Recall of trauma exposures and lifetime PTSD symptomatology is retrospective and subject to stigma, such that the levels disclosed here could be under-reported. Conversely, women could erroneously report pregnancy symptoms as PTSD symptoms, decreasing specificity. Not all eligible women accepted the invitation to participate or were reached for the survey, and we have no data about

those who did not consent and complete the survey. We did not analyse racial or ethnic groups other than African Americans. We only included women giving birth for the first time, so we do not know the impact of having had a previous traumatic birth or of previous stillbirth or loss of a child; and we do not know if PTSD affects outcomes of subsequent pregnancy to the same extent as it affects the first pregnancy. Nor did we have enough women with other high-magnitude exposures (e.g. intimate partner violence survivors, combat veterans, refugees) to know the specific effects of these trauma exposures on perinatal health.

There are also several strengths to this study including the three-cohort design, the large, diverse sample, and the organising framework that considers additional relevant predictors including depression, substance use, recent intimate partner violence, medical and obstetric risk, prenatal care and mental health treatment, race and poverty. The ability to stratify to examine abuse-related PTSD specifically was also a strength because this trauma exposure in early development may have been a factor in the inconsistent findings of previous studies, particularly in disaster research where other lifetime exposures are seldom analysed. The potential limitations in trauma history and PTSD measurement were anticipated and addressed by choosing well-established, standardised instruments and a survey research organisation experienced in the conduct of mental health research. The Life Stressor Checklist is an established trauma history measure designed specifically for use with women. It queries trauma exposures with behaviourally specific language, separating the query about whether the exposure happened (yes/no) from the evaluation that it was traumatic (i.e. that the woman felt fear, helplessness or horror) to increase reliability of reporting. We examined the validity of PTSD symptom reporting during pregnancy by comparing the results of our pregnancy survey with the age-matched sample from the National Women's Study[50] and concluded that the symptom reporting appears to be highly specific to PTSD. The collaboration of three major medical centres permitted inclusion of both affluent and disadvantaged women who would have experienced a range of high- and low-risk models of care with diverse maternity care providers, including trainees and faculty members in obstetrics, family medicine and midwifery. These strengths contribute to both internal validity and generalisability.

Clinical implications follow from these findings. Assessment for trauma history and PTSD using brief measures validated for primary-care settings should be implemented in addition to the depression assessment that is becoming a standard of care. PTSD-affected women should be offered an opportunity to discuss their traumatic stress concerns with a maternity care team member. Referral to specialty care to have decision-making help using evidence-based treatments for PTSD in pregnancy may be desired by some pregnant women. Nursing or education visits to address concerns regarding labour, breastfeeding or early parenting are likely to be more widely accepted. Interdisciplinary collaboration will probably be useful to maternity care professionals in the short term. Referral is unlikely to be a sufficient response because intrusive medical procedures and labour are particularly triggering situations where it is the maternity care provider who is involved and able to adapt care to make these situations less stressful. Consulting with mental health professionals experienced in working with PTSD can help maternity care providers to increase their comfort and skill as they add addressing trauma-related needs to the list of treatment modalities they offer.

There are numerous research implications. PTSD-specific interventions for pregnant women are urgently needed, with priority efforts going toward developing programmes that are feasible to implement in low-resource settings, culturally acceptable to minority women, and tailored to address the needs of women with abuse-related PTSD. Studies are also needed to assess the pregnancy-specific benefit–risk profile of existing evidence-based specialty treatments for PTSD (e.g. exposure therapy) and pharmacotherapies (e.g. selective serotonin reuptake inhibitors). Given the effect size of PTSD on the outcomes of birthweight and gestational age, studies are needed on the effects of PTSD on other maternal–child outcomes (e.g. labour processes, breastfeeding, postpartum mental health and bonding). Biological research is needed to understand the possibly distinct mechanisms of lower birthweight and shorter gestation in PTSD-affected women, especially those with a childhood maltreatment history. Studies are also needed to examine the effect of PTSD on the birth outcomes of other highly traumatised groups, including veterans and refugees, and also on the birth outcomes of multiparous women where previous perinatal loss or traumatic birth may be important antecedent exposures.

Conclusion

The findings of this investigation provide a substantial contribution to our understanding of the effects of PTSD on the perinatal outcomes of birthweight and gestational age in this sample. In particular these findings indicate that PTSD in pregnancy accounts for a decrement of over 200 g in birthweight, a difference that is more weakly correlated with gestational age among affected women than among controls. These findings further suggest that it may be the greater risk that African Americans carry for having PTSD during pregnancy,[6] rather than race alone, that accounts for some of the disparity in birth outcomes. The models also indicate that it is the subset of women whose

PTSD is secondary to childhood abuse who are most vulnerable to these lower birthweight and shorter gestation outcomes and that prenatal care is not protective for them. Addressing abuse-related PTSD in maternity care settings is therefore an additional avenue for improving the childbearing experience, mental health and perinatal outcomes of socio-demographically and psychologically vulnerable women.

Disclosure of interests

The authors have no interests to declare.

Contribution to authorship

JS, LKL, DR and IL are co-investigators, and MS is the study coordinator. JS and DR undertook the data analysis. All authors' contributions to the manuscript are consistent with co-authorship.

Details of ethics approval

The Institutional Review Boards of all three medical centres approved and oversaw the conduct of research for this project; University of Michigan IRBMED #2004-1046, Henry Ford Health System IRB #3533, Wayne State University HIC #059105B3E.

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Supporting information

The following supplementary materials are available for this article:

Data S1. Powerpoint slides summarising the study.

Table S1. (a) Overview of studies of gestational age and birthweight that analysed PTSD as a risk factor in community or prenatal samples. (b) Overview of studies of gestational age and birthweight that analysed PTSD as a risk factor in disaster samples.

Table S2. Measures used to collect data for variables in the regression models.

Table S3. Regression of conceptual framework predictors on the outcome of birth weight with the whole sample and stratified by childhood abuse history.

Table S4. Regression of conceptual framework predictors on the outcome of gestational age with the whole sample and stratified by childhood abuse history.

Additional Supporting Information may be found in the online version of this article.

Please note: Wiley-Blackwell are not responsible for the content or functionality of any supporting information supplied by the authors. Any queries (other than missing material) should be directed to the corresponding author. ■

References

1 Kaminer D, Grimsrud A, Myer L, Stein DJ, Williams DR. Risk for posttraumatic stress disorder associated with different forms of interpersonal violence in South Africa. *Soc Sci Med* 2008;67:1589–95.
2 Hapke U, Schumann A, Rumpf HJ, John U, Meyer C. Post-traumatic stress disorder: the role of trauma, pre-existing psychiatric disorders, and gender. *Eur Arch Psychiatry Clin Neurosci* 2006;256:299–306.
3 Creamer M, Burgess P, McFarlane AC. Post-traumatic stress disorder: findings from the Australian National Survey of Mental Health and Well-being. *Psychol Med* 2001;31:1237–47.
4 de Jong JT, Komproe IH, Van Ommeren M, El Masri M, Araya M, Khaled N, et al. Lifetime events and posttraumatic stress disorder in 4 postconflict settings. *JAMA* 2001;286:555–62.
5 Seng JS, Low LK, Sperlich M, Ronis DL, Liberzon I. Prevalence, trauma history, and risk for posttraumatic stress disorder among nulliparous women in maternity care. *Obstet Gynecol* 2009;114:839–47.
6 Seng JS, Kohn-Wood LP, McPherson MD, Sperlich M. Disparities in trauma history and posttraumatic stress disorder in a community sample of pregnant women. *Arch Women's Mental Health*. 15 May 2011 [Epub ahead of print].
7 Center for Healthcare Research and Transformation. Issues brief on prematurity, released November 16, 2010. [www.chrt.org/assets/price-of-care/CHRT-Issue-Brief-November-2010.pdf]. Last accessed 3 July 2011.
8 Talge NM, Holzman C, Wang J, Lucia V, Gardiner J, Breslau N. Late-preterm birth and its association with cognitive and socioemotional outcomes at 6 years of age. *Pediatrics* 2010;126:1124–31.
9 Seng JS, Oakley DJ, Sampselle CM, Killion C, Graham-Bermann S, Liberzon I. Posttraumatic stress disorder and pregnancy complications. *Obstet Gynecol* 2001;97:17–22.
10 Rogal SS, Poschman K, Belanger K, Howell HB, Smith MV, Medina J, et al. Effects of posttraumatic stress disorder on pregnancy outcomes. *J Affect Disord* 2007;102:137–43.
11 Rosen D, Seng JS, Tolman RM, Mallinger G. Intimate partner violence, depression, and posttraumatic stress disorder as additional predictors of low birth weight infants among low-income mothers. *J Interpers Violence* 2007;22:1305–14.
12 Morland L, Goebert D, Onoye J, Frattarelli L, Derauf C, Herbst M, et al. Posttraumatic stress disorder and pregnancy health: preliminary update and implications. *Psychosomatics* 2007;48:304–8.
13 Berkowitz GS, Wolff MS, Janevic TM, Holzman IR, Yehuda R, Landrigan PJ. The World Trade Center disaster and intrauterine growth restriction. *JAMA* 2003;290:595–6.
14 Chang HL, Chang TC, Lin TY, Kuo SS. Psychiatric morbidity and pregnancy outcome in a disaster area of Taiwan 921 earthquake. *Psychiatry Clin Neurosci* 2002;56:139–44.
15 Engel SM, Berkowitz GS, Wolff MS, Yehuda R. Psychological trauma associated with the World Trade Center attacks and its effect on pregnancy outcome. *Paediatr Perinat Epidemiol* 2005;19:334–41.

16 Xiong X, Harville EW, Mattison DR, Elkind-Hirsch K, Pridjian G, Buekens P. Exposure to Hurricane Katrina, post-traumatic stress disorder and birth outcomes. *Am J Med Sci* 2008;336:111–5.

17 Lipkind HS, Curry AE, Huynh M, Thorpe LE, Matte T. Birth outcomes among offspring of women exposed to the September 11, 2001, terrorist attacks. *Obstet Gynecol* 2010;116:917–25.

18 Heim C, Ehlert U, Hellhammer DH. The potential role of hypocortisolism in the pathophysiology of stress-related bodily disorders. *Psychoneuroendocrinology* 2002;25:1–35.

19 Inslicht SS, Marmar CR, Neylan TC, Metzler TJ, Hart SL, Otte C, et al. Increased cortisol in women with intimate partner violence-related posttraumatic stress disorder. *Psychoneuroendocrinology* 2006;31:825–38.

20 Van de Kolk BA, Roth S, Pelcovitz D, Sunday S, Spinazzola J. Disorders of extreme stress: the empirical foundation of a complex adaptation to trauma. *J Trauma Stress* 2005;18:389–99.

21 Cloitre M, Stolbach B, Herman J, Kolk B, Pynoos R, Wang J, et al. A developmental approach to complex PTSD: childhood and adult cumulative trauma as predictors of symptom complexity. *J Traum Stress* 2009;22:399–408.

22 Breslau N, Davis GC, Peterson EL, Schultz L. Psychiatric sequelae of posttraumatic stress disorder in women. *Arch Gen Psychiatry* 1997;54:81–7.

23 Seng JS. A conceptual framework for research on lifetime violence, posttraumatic stress, and childbearing. *J Midwifery Womens Health* 2002;47:337–46.

24 Petersen R, Saltzman LE, Goodwin M, Spitz A. Key scientific issues for research on violence occurring around the time of pregnancy. Report prepared for the CDC. April 1998. [Available via Ms Spitz, Division of Reproductive Health, K-35, CDC, 4770 Buford Hwy, Atlanta, GA 30341-3724 and via www.cdc.gov/reproductive health/ProductsPubs/ArchivePubs.htm]. Last accessed 3 July 2011.

25 Liberzon I, Taylor SF, Amdur R, Jung TD, Chamberlain KR, Minoshima S, et al. Brain activation in PTSD in response to trauma-related stimuli. *Biol Psychiatry* 1999;45:817–26.

26 Seng JS, Mugisha E, Miller JM. Reliability of a perinatal outcomes measure: the Optimality Index-US. *J Midwifery Womens Health* 2008;53:110–4.

27 Waltz C, Strickland O, Lenz E. *Measurement in Nursing Research*. Philadelphia: F.A. Davis, 1991.

28 Wolfe J, Kimerling R. Gender issues in the assessment of posttraumatic stress disorder. In: Wilson JP, Keane TM, editors. *Assessing Psychological Trauma and PTSD*. New York: Guilford; 1997. pp. 192–238.

29 Resnick HS, Kilpatrick DG, Dansky BS, Saunders BE, Best CL. Prevalence of civilian trauma and posttraumatic stress disorder in a representative national sample of women. *J Consult Clin Psychol* 1993;61:984–91.

30 Beck LF, Morrow B, Lipscomb LE, Johnson CH, Gaffield ME, Rogers M, et al. Prevalence of selected maternal behaviors and experiences, Pregnancy Risk Assessment Monitoring System (PRAMS), 1999. *MMWR Surveill Summ* 2002;51:1–27.

31 Wittchen HU. Reliability and validity studies of the WHO—Composite International Diagnostic Interview (CIDI): a critical review. *J Psychiatr Res* 1994;28:57–84.

32 McFarlane J, Parker B, Soeken K, Bullock L. Assessing for abuse during pregnancy. Severity and frequency of injuries and associated entry into prenatal care. *JAMA* 1992;267:3176–8.

33 Seng JS. Posttraumatic oxytocin dysregulation: is it a link among posttraumatic self disorders, posttraumatic stress disorder, and pelvic visceral dysregulation conditions in women? *J Trauma Dissociation* 2010;11:387–406.

34 Sohlstrom A, Carlsson-Skwirut C, Bang P, Brismar K, Uvnas-Moberg K. Effects of oxytocin treatment early in pregnancy on fetal growth in ad libitum-fed and food-restricted rats. *Pediatr Res* 1999;46:339–44.

35 Pace TW, Heim CM. A short review on the psychoneuroimmunology of posttraumatic stress disorder: from risk factors to medical comorbidities. *Brain Behav Immun* 2011;25:6–13.

36 Green NS, Damus K, Simpson JL, Iams J, Reece EA, Hobel CJ, et al. Research agenda for preterm birth: recommendations from the March of Dimes. *Am J Obstet Gynecol* 2005;193:626–35.

37 Class QA, Lichtenstein P, Langstrom N, D'Onofrio B. Timing of prenatal maternal exposure to severe life events and adverse pregnancy outcomes: a population study of 2.6 million pregnancies. *Psychosom Med* 2011;73:234–41.

38 Bolten MI, Wurmser H, Buske-Kirschbaum A, Papousek M, Pirke KM, Hellhamer D. Cortisol levels in pregnancy as a psychobiological predictor for birth weight. *Arch Womens Ment Health* 2011;14:33–41.

39 Breslau N. The epidemiology of posttraumatic stress disorder: what is the extent of the problem? *J Clin Psychiatry* 2001;62 (Suppl 17):16–22.

40 Bollini P, Pampallona S, Wanner P, Kupelnick B. Pregnancy outcome of migrant women and integration policy: a systematic review of the international literature. *Soc Sci Med* 2009;68:452–61.

41 Myer L, Stein DJ, Grimsrud A, Seedat S, Williams DR. Social determinants of psychological distress in a nationally-representative sample of South African adults. *Soc Sci Med* 2008;66:1828–40.

42 Sperlich M, Seng J. *Survivor Moms: Women's Stories of Birthing, Mothering, and Healing after Sexual Abuse*. Eugene, OR: Motherbaby Press, 2008.

43 American College of Obstetricians and Gynecologists. *Adult Manifestation of Childhood Sexual Abuse*. ACOG Education Bulletin: number 259. Washington, D. C.: The College; 2000.

44 American College of Obstetricians & Gynecologists. *Domestic Violence*. ACOG Education Bulletin number 257. Washington, D. C.: The College; 1999.

45 Bohn DK, Holz KA. Sequelae of abuse. Health effects of childhood sexual abuse, domestic battering, and rape. *J Nurse Midwifery* 1996;41:442–56.

46 Finkelhor D, Turner H, Ormond R, Hamby SL. Violence, abuse, and crime exposure in a national sample of children and youth. *Pediatrics* 2009;124:1411–23.

47 Forbes D, Creamer M, Bisson JI, Cohen JA, Crow BE, Foa EB, et al. A guide to guidelines for the treatment of PTSD and related conditions. *J Traum Stress* 2010;23:537–52.

48 Noll JG, Schulkin J, Trickett PK, Susman EJ, Breech L, Putnam FW. Differential pathways to preterm delivery for sexually abused and comparison women. *J Pediatr Psychol* 2007;32:1238–48.

49 Leeners B, Richter-Appelt H, Imthurn B, Rath W. Influence of childhood sexual abuse on pregnancy, delivery, and the early postpartum period in adult women. *J Psychosom Res* 2006;61:13951.

50 Seng JS, Rauch SA, Resnick H, Reed CD, King A, Kane Low L, et al. Exploring posttraumatic stress disorder symptom profile among pregnant women. *J Psychosom Obstet Gynaecol* 2010;31:176–87.

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Discussion points

1. Background: Discuss the implications of PTSD for care in pregnancy and the puerperium.
2. Methods: In this study women who needed an interpreter were excluded. Discuss the use of relatives versus professional interpreters for vulnerable women who do not speak fluently the language of their caregivers.[1] Critically appraise the use of computer-assisted telephone interviews for diagnostic and research purposes.[2] Discuss the interaction between gestational age and birthweight, and how the authors of this study dealt with it in data analysis and interpretation.
3. Results and implications: Prenatal care was not associated with better outcomes among women abused in childhood in this study. Discuss possible reasons and brainstorm ways to improve care for women with PTSD with or without childhood abuse (Data S1). ■

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References

1 Centre for Maternal and Child Enquiries. Saving Mothers' Lives: reviewing maternal deaths to make motherhood safer: 2006–2008. *BJOG* 2011;118:1–203.
2 Dansky BS, Saladin ME, Brady KT, Kilpatrick DG, Resnick HS. Prevalence of victimization and posttraumatic stress disorder among women with substance use disorders: comparison of telephone and in-person assessment samples. *Int J Addict* 1995;30:1079–99.

