Psychosocial stress during pregnancy and perinatal outcomes: a meta-analytic review

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Abstract
The objective of this study was to evaluate the relationship between psychosocial stress in pregnancy and negative perinatal outcomes and to identify key moderators of this relationship. To evaluate this relationship, a meta-analytic review was conducted of studies that prospectively assessed the relationship between psychosocial stress in pregnancy and perinatal outcomes. A total of 35 studies, written or published between 1991 and 2009, involving 31,323 women were located. The overall association between psychosocial stress and negative perinatal outcomes was significant, but negligibly small in size (r(35) = 0.04, CI = 0.08, 0.01). Examining specific perinatal outcomes, only the associations with neonatal weight (r(14) = 0.07, CI = 0.03, 0.01) and risk for low birth weight (r(5) = 0.07, CI = 0.03, 0.10) were statistically significant, but again, very small. Results support that psychosocial stress explains a negligible to very small amount of the variability in perinatal outcomes. Future research should focus on identifying other psychosocial and lifestyle variables that alone or in interaction with other factors explain larger amounts of the variability in perinatal outcomes. Future research should also examine whether psychosocial stress increases risk for negative outcomes in combination with other biomedical and psychosocial risk factors.

Keywords: IUGR, low birth weight, perinatal outcomes, preterm delivery, stress

Introduction
Efforts to improve pregnancy outcomes have been greatly hampered by an inability to fully predict who will develop pregnancy complications and thus intervene to potentially prevent such complications. For example, biomedical factors have been estimated to account for only about 50% of the incidents of low birth weight (LBW) and premature infants [1]. As a result, increasing attention has been paid to the potential role of psychosocial factors in leading to negative perinatal outcomes. One such factor that has been the focus of much research and clinical attention is the experience of psychosocial stress by the expectant mother. Indeed, the American College of Obstetricians and Gynaecologists recommend that practitioners screen expectant mothers for psychosocial stress, stating that it may be associated with preterm delivery and LBW [1].

A number of potential pathways through which the experience of psychosocial stress by the mother may lead to negative perinatal outcomes have been proposed. One possibility is that women who experience stress during pregnancy may be more likely to engage in poor health practices such as drinking alcohol, smoking, skipping prenatal visits, entering prenatal care late and skipping meals or engaging in other poor eating habits [2–5]. Neuroendocrine responses to stress could also contribute to negative perinatal outcomes through a number of mechanisms. These include elevations in corticotrophin releasing factor (CRH) leading to initiation of preterm labour and increased risk of preterm delivery, as well as catecholamine release affecting the tone of peripheral blood vessels and contributing to the development of pre-eclampsia, growth retardation or preterm delivery [2,4,6–9]. In addition, the release of glucocorticoids and catecholamines may reduce cellular immunity.
This could then result in increased risk for developing an infection such as bacterial vaginosis, which in turn increases vulnerability to preterm delivery [3,7].

Research examining the relationship between stress and perinatal outcomes has had mixed findings, however [5,10]. Indeed, some researchers have concluded that there is strong and convincing evidence for an association of psychosocial stress with multiple negative perinatal outcomes [3,9]. In contrast, others have concluded that there is weak and conflicting evidence for an association between stress and negative perinatal outcomes [2,10]. These inconsistencies may be in part related to differences among studies, including in how stress was conceptualised and when stress was assessed during pregnancy, as well as differences in the sample assessed. For example, it is possible that only more serious stressors (e.g., life events such as divorce, loss of a loved one, losing one’s job) or stressors the woman perceives as particularly distressing have an effect on perinatal outcomes. In addition, stressors may vary in their effect depending on when they occur during pregnancy; for example, stressors that occur in the third trimester may increase risk for preterm delivery through alterations in levels of CRH [7]. Finally, psychosocial stress may be more strongly associated with negative outcomes in samples at elevated risk for such outcomes. As an example, African American women in the US have consistently been found to be at elevated risk for preterm delivery and for having a LBW baby relative to European American women, and thus, stress may have a greater impact on African American women’s risk for these outcomes as compared to women of other ethnicities [8,11].

Given the inconsistencies in the findings of prior studies examining the relationship between psychosocial stress during pregnancy and perinatal outcomes and the possibility that some of these inconsistencies could be accounted for by methodological and sample differences among studies, the current investigation sought to evaluate through meta-analysis the relationship between psychosocial stress during pregnancy and perinatal outcomes. In addition, a number of potential moderators of the relationship between stress and negative outcomes were evaluated.

**Methods**

**Search strategy**

Potential studies were retrieved by the investigators from PsycInfo (1966 to July 2009), MEDLINE (1967 to July 2009), and Health Reference Centre Academic (1995 to July 2009) using combinations of the following keywords: stress, pregnancy, premature, complications, pre-eclampsia, birth weight, miscarriage, labour and gestation. References of retrieved articles were scanned and prominent researchers were contacted for any unpublished or in press studies. Studies written or published in English were accepted.

**Selection**

Studies were included in the meta-analysis if they assessed self-reported psychosocial stress (e.g., life events, hassles, perceived stress) using a validated measure at one or more time points during pregnancy. Additionally, studies had to report sufficient data to calculate an effect size (Pearson or Spearman rho correlation coefficient) between stress and at least one specific perinatal outcome. Studies were excluded if they had only retrospective reports of psychosocial stress measured in the postnatal period given the likelihood that retrospective reports would lead to a spurious relationship between stress and perinatal outcome [12]. Studies were also excluded if they only evaluated a composite measure of perinatal outcomes (which are not regarded as methodologically sound) [5], assessed a perinatal outcome not evaluated in at least one other study, or if data necessary to calculate an effect size could not be obtained from the study or the authors (authors were contacted when the information necessary to calculate an effect size was not provided for all studies written or published in 2000 or later). Studies were also excluded if they assessed outcomes in the postnatal period (e.g., amount of infant crying during the first week, handedness). In addition, studies that evaluated physical stress/strain (e.g., number of hours standing per day) were excluded. Finally, studies that assessed a related but distinct construct (e.g., prenatal anxiety or depression) rather than psychosocial stress, were excluded as prior recent quantitative reviews had assessed the association between these constructs and perinatal outcomes [13,14].

**Data extraction**

All data were coded by the first author, a doctoral level researcher who has previously published several meta-analytic reviews. In addition, the other authors, doctoral students, verified the coding of approximately 74% of the cases. Standardised data collection forms were developed a priori for data extraction. The average inter-coder agreement was 93.5%. In cases of discrepancies in coding, consensus was reached through conferral. In addition, all studies were coded a second time by the first author to verify initial coding.

**Study characteristics**

Recorded parameters in each study included year of publication or year written, publication status, the average maternal age of the sample, the average...
gestational age of participants at the psychosocial stress assessment, country where the study was conducted, sample size, percentage of ethnic minority participants, percentage of women who were primiparous or primigravid and type of stress assessed. Specifically, the type of psychosocial stress assessed was placed into one of four categories: number of stressful life events, hassles or minor stressors, perceived stress and appraised stressful life events (measured with a life events checklist where participants indicated whether the particular event was appraised as stressful by them).

The type of study was also coded. Specifically, three types of studies were included in the meta-analysis: case-control studies, cohort studies and prospective observational studies. Case-control studies compared the level of stress reported during pregnancy among women who experienced a negative pregnancy outcome (e.g., LBW, intrauterine growth restriction (IUGR)) to those who did not experience this outcome. Cohort studies compared pregnancy outcomes in women who experienced a stressful event during pregnancy or a certain level of stress during pregnancy to those women who did not experience stress. Finally, prospective observational studies examined the extent to which women’s reported level of stress during pregnancy predicted continuous pregnancy outcomes (e.g., neonatal weight, gestational age). Study quality was also recorded. Unfortunately, there are no consensus guidelines for evaluating study quality in non-experimental studies and thus there is no ‘gold standard’ quality rating tool available [15]. In the current study, the Newcastle-Ottawa Scale (NOS) was used [16]. Research supports this measure’s content validity as assessed by expert raters, as well as its inter-rater reliability [16]. The NOS is a checklist which awards points to a study based on the presence of certain characteristics including the representativeness of the sample, lost to follow-up rate and the method utilised to ascertain exposure and outcome. The NOS has separate checklists for cohort and case-control studies. The NOS checklist includes a category for whether the study controlled for the most relevant factor related to the outcome. However, in the current study, this category was not coded because the most relevant factor to control for is not clearly established for the negative perinatal outcomes under consideration. As a result, each study could receive a quality score ranging from 0 to 7. Of note, prospective observational studies were coded for quality using the cohort study form.

Analysis

Outcomes were included in the meta-analysis if they occurred during pregnancy or immediately following birth and were assessed in at least two separate studies. A total of eight outcomes met criteria for inclusion: gestational age at delivery, IUGR, pre-eclampsia, 5 min Apgar score, preterm delivery, birth weight, LBW and birth weight adjusted for gestational age at delivery. Definitions of outcomes followed those most commonly utilised in the literature: IUGR was defined as weight less than the 10th percentile for gestational age, preterm delivery was defined as delivery prior to 37 weeks gestation and LBW was defined as birth weight less than 2500 g.

Correlation coefficients were calculated as an effect size measure [17]. Correlation coefficients were chosen as the measure of effect size for several reasons. First, as several of the outcomes assessed were continuous (e.g., neonatal weight, gestational age) use of an odds ratio was not feasible. In addition, because stress was often measured using non-dichotomous variables, interpretation of the odds ratio in these cases is complex as the odds ratio refers to the increase or decrease in odds of the outcome associated with a one-point increase on the predictor measure. Finally, correlation coefficients were regarded as easily interpretable, as squaring a correlation provides the variance in outcome explained by psychosocial stress.

If a Pearson correlation coefficient was not reported in the study, the effect size measure reported was converted to a correlation coefficient using the procedures recommended by Rosenthal [17]. In addition, odds ratios were transformed using the tetrachoric correlation approximation suggested by Bonnett [18]. Separate correlation coefficients were calculated for each perinatal outcome reported as well as for each type of psychosocial stress measure administered, and for each stress assessment administered during pregnancy. Before conducting analyses, an overall effect size was calculated for each study by averaging all the effect sizes. Specifically, for all studies with multiple stress assessments, a weighted average effect size across all assessments was calculated. Similarly, for studies that assessed multiple perinatal outcomes, a weighted average effect size across all outcomes was calculated. If a study had multiple stress assessment points and assessed multiple perinatal outcomes, then all the effect sizes were combined to calculate an overall weighted average effect size across both outcomes and stress assessment points. Before combining effect sizes within studies, if necessary, the signs of the effect sizes were reversed so that a negative effect size corresponded to an association of greater psychosocial stress with worse perinatal outcomes. Combining effect sizes was necessary to prevent studies with multiple outcomes or assessments from receiving more weight in the overall and moderator analyses than studies with fewer outcomes and assessments.

For each outcome, the mean correlation coefficient weighted by sample size was calculated as was the 95% confidence interval (CI) for the obtained
correlation coefficient using a theta estimation random effects model [19]. Random effects models treat effect size parameters as if they were a random sample and result in more conservative estimates of confidence intervals and lower Type I error rates (i.e., spurious relationships) than fixed effects models [12,20,21]. Cochran’s $Q$ was computed as a measure of the heterogeneity of obtained effect sizes. A non-significant test of heterogeneity suggests that any variability in effect sizes is due to random error, as opposed to moderator variables [22].

If there was significant heterogeneity, moderator analyses were conducted using weighted least squares regressions (WLS) [19]. WLS regressions weigh correlations based on the inverse sampling-error and were chosen because of evidence suggesting that they produce more accurate estimates as compared to other moderator analysis techniques [23]. A significant WLS regression was followed by contrast analyses comparing the effect sizes among levels of the moderator for categorical variables and comparing the effect sizes within each quartile of the moderator for continuous variables. Cochran’s $Q$ values were also computed for the obtained effect sizes within each level of the potential moderator to evaluate whether the moderator explained the heterogeneity of effect sizes found.

Publication bias was evaluated with Begg’s rank correlation test [24]. This test involves converting effect sizes to Z scores and then calculating the number of concordant and discordant study pairs with regard to the studies’ Z scores and sample sizes. A statistically significant Z score suggests the presence of publication bias. This test was chosen because it has demonstrated superior performance to other extant tests with regard to Type I error control and power [25]. In addition, potential study outliers were identified using a modified version of the Huffcutt and Arthur outlier procedure [26]. This procedure involves assessing the difference between each individual effect size and the sample-weighted mean effect size (coded as Fisher’s Z values) and then adjusting this raw deviancy value for sampling error in the effect size and the mean effect size [26,27]. A value over 2.25 suggests that the effect size is an outlier. The mean effect size was then recalculated with any outliers removed.

**Results**

After reviewing study abstracts, a total of 190 studies were selected for further review. Of these, 155 were excluded with the most common reasons for exclusion being that the article was a qualitative review, used a retrospective report of stress in the postnatal period, evaluated a composite perinatal outcome, assessed a related construct rather than psychosocial stress, or did not include sufficient information to calculate an effect size. A total of 35 studies assessing 31,323 women were retained in the meta-analysis [2,11,28–61]. These studies were published or written between 1987 and 2009. Characteristics of included studies are summarised in Table I. Of these studies, 16 were prospective observational studies, 10 were cohort studies and 9 were case–control studies. The average quality assessment overall was 4.97 and was similar across study type (observational $M = 5.0$, range 3–7; cohort $M = 4.8$, range 3–6; case–control $M = 5.1$, range 4–6). Characteristics present in nearly all studies were: ascertainment of perinatal outcomes via record linkage, adequate follow-up to ascertain outcomes, moderate representativeness of the sample, and selection of non-exposed individuals and controls from the same community as exposed individuals and cases. In addition, as all the studies included in the current investigation were prospective, in no cases was the outcome present at the start of the study. In contrast, most studies assessed exposure to stress via self-report (as opposed to a structured interview), most did not state that they excluded participants from case–control studies that previously had the negative outcome under consideration, and many provided inadequate information about participants who were lost to follow-up (e.g., whether there were significant differences between those who were lost to follow-up and those who were not or whether there were differences in lost to follow-up rates in cases and controls).

The overall association between psychosocial stress during pregnancy and perinatal outcomes was quite small but significant ($r(35) = -0.04$, 95% CI = $-0.08$, $-0.01$), and there was significant heterogeneity in the effect sizes ($\chi^2(34) = 132.92$, $p < .005$). Begg’s rank correlation test did not support the existence of significant publication bias ($Z = 0.13, p = 0.45$). Outlier analyses revealed five effect size outliers. The values and sample sizes of the outliers were: $r_s = -0.43$ (n = 82), $-0.26$ (n = 345), $-0.23$ (n = 357), 0.11 (n = 1549), $-0.04$ (n = 5092) [39–42,48]. Evaluating these study outliers, three utilised a dichotomous rather than continuous measure of stress, which could have resulted in biased estimates due to the loss of information involved in dichotomizing the stress measure [39,42,48]. The study with the largest obtained effect size had a sizable lost to follow-up rate of nearly 40% and a very small sample size of 82 women (of whom only 11 delivered preterm, which was the outcome evaluated), bringing into question the validity of this result [40]. One of the other studies with a larger effect size of $-0.26$ compared women with the highest and lowest stress scores on their risk for developing pre-eclampsia, potentially resulting in a higher estimate of the association between stress and risk for pre-eclampsia [48]. The overall association between stress during pregnancy and negative perinatal outcomes after removing these five outliers remained significant ($r(23) = -0.04$, 95% CI =
and there was no longer significant heterogeneity in the effect sizes, $\chi^2(29) = 27.4$, $p = 0.55$. A stem and leaf plot of all un-weighted obtained effect size is provided in Table II.

The association between psychosocial stress during pregnancy and each perinatal outcome assessed is summarised in Table III. Only two of the associations between stress during pregnancy and specific
perinatal outcomes were statistically significant. Specifically, psychosocial stress during pregnancy was significantly associated with lower neonatal weight and a greater risk of LBW. In both cases, stress on average explained 0.5% of the variance in these two outcomes.

Given that there was significant heterogeneity in the overall effect size, WLS regressions were conducted to examine potential moderators of the association between stress during pregnancy and negative perinatal outcomes. Several of the WLS regressions were significant, suggesting the presence of potential moderators. These potential moderators were: the type of stress assessed (e.g., stressful life events, hassles), the percentage of ethnic minority participants in the sample, the country where the study was conducted, year of publication/year written of the study, the percentage of primiparous/primigravid participants in the sample, study type and study quality. Of these potential moderators, five explained significant heterogeneity in the obtained effect sizes: the type of stress assessed by the study, the percentage of European American participants in the sample, the percentage of primiparous or primigravid participants in the sample, study type and study quality. The obtained effects, 95% CI, study and participant sample sizes, and significance of test of heterogeneity for studies stratified by level of these moderator variables are summarised in Table IV.

Contrast analyses supported that the mean effect size in studies that assessed hassles significantly differed from the mean effect size for studies that assessed negative life events appraised as stressful by the participant. Contrast analyses also supported that the mean effect size found in studies with the smallest percentage of European American participants (0–48%) differed significantly from the mean effect size found in studies with the largest percentage of

Table II. Stem and leaf plot of all obtained effect sizes for studies included in meta-analysis*.

<table>
<thead>
<tr>
<th>Mean</th>
<th>95% CI</th>
<th>Variance explained</th>
<th>Study, N</th>
<th>Total, N</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestational age</td>
<td>-0.04</td>
<td>-0.08, 0.00</td>
<td>0.2%</td>
<td>12</td>
<td>2159</td>
</tr>
<tr>
<td>IUGR</td>
<td>0.04</td>
<td>-0.04, 0.11</td>
<td>0.2%</td>
<td>7</td>
<td>12,639</td>
</tr>
<tr>
<td>Pre-eclampsia</td>
<td>-0.03</td>
<td>-0.54, 0.50</td>
<td>0.1%</td>
<td>2</td>
<td>796</td>
</tr>
<tr>
<td>5-minute Apgar score</td>
<td>0.02</td>
<td>-0.09, 0.13</td>
<td>0.1%</td>
<td>5</td>
<td>1653</td>
</tr>
<tr>
<td>Preterm delivery</td>
<td>0.04</td>
<td>-0.03, 0.11</td>
<td>0.2%</td>
<td>13</td>
<td>22,613</td>
</tr>
<tr>
<td>Adjusted weight</td>
<td>0.00</td>
<td>-0.06, 0.06</td>
<td>0.0%</td>
<td>4</td>
<td>1168</td>
</tr>
<tr>
<td>Low birth weight</td>
<td>0.07</td>
<td>0.03, 0.10</td>
<td>0.5%</td>
<td>5</td>
<td>3261</td>
</tr>
<tr>
<td>Neonatal weight</td>
<td>-0.07</td>
<td>-0.13, -0.01</td>
<td>0.5%</td>
<td>14</td>
<td>2786</td>
</tr>
</tbody>
</table>

Mean r = mean correlation weighted by sample size; 95% CI = 95% confidence interval of effect size; Q = significance of test of heterogeneity.

If necessary, sign of effect was reversed so that a negative relationship meant that stress was associated with worse perinatal outcomes.

*If necessary, sign of effect was reversed so that a negative relationship meant that stress was associated with worse perinatal outcomes.

**Pre-eclampsia.

*5-minute Apgar score.

†IUGR.

Cambal weight.

*Gestational age.

**Gestational age.

†Adjusted weight.

††Preterm delivery.

†††Low birth weight.

Table III. Meta-analytic statistics of associations between stress during pregnancy and perinatal outcomes.
European American participants (84.5–100%). Contrast analyses supported that the mean effect size found for studies in the third quartile of percentage of primiparous or primigravid participants (56–62%) differed significantly from the mean effect size for studies in the first (0–30%), or second (32.5–50%) quartiles of percentage of primiparous or primigravid participants. Contrast analyses also supported that the mean effect size for cohort studies was significantly different from the average effect sizes of the other two study types. Finally, contrast analyses supported that studies that received a study quality rating of three differed significantly from studies that received a study quality rating of four, five or six (only one study received a study quality of seven and thus a mean effect size could not be calculated).

**Discussion**

Results overall suggested that the relationship between psychosocial stress and negative perinatal outcomes, while statistically significant, is quite small, and unlikely to be clinically meaningful. Indeed, examination of the stem and leaf plot of all raw effect sizes supported that the obtained effects clustered slightly below 0. In addition, there was inconsistency in the strength of results across outcomes, with the strongest evidence found for a relationship between psychosocial stress and neonatal weight, including risk for LBW. However, even for these two outcomes psychosocial stress explained less than 1% of the variability, and thus stress is again unlikely to have clinical significance.

While the overall relationship between psychosocial stress and perinatal outcomes was quite small, some notable moderators of the relationship were identified in the current study. First, examining the type of psychosocial stress experienced, minor stressors were more weakly related to perinatal outcomes than the other types of stress, whereas major life events appraised as stressful were more strongly related to negative outcomes than the other types of stress. This suggests that a stressor has to be of significant magnitude to be appraised as highly stressful by the expectant mother to have a potential impact on risk for negative perinatal outcomes. However, again it should be noted that appraised stressful events on average explained less than 1% of the variability in outcomes. Another moderator identified was the percentage of ethnic minority participants. Specifically, the relationship between psychosocial stress and perinatal outcomes was stronger in samples with larger percentages of ethnic minority women. One potential explanation for this finding is that ethnic minority women are at greater risk of experiencing stressors of significant intensity to have an impact on their risk for negative perinatal outcomes, perhaps due to their greater socioeconomic disadvantage, or as a result of the

<table>
<thead>
<tr>
<th>Moderator</th>
<th>Mean r</th>
<th>95% CI</th>
<th>Study N</th>
<th>Total N</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of stress assessed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life events</td>
<td>−0.05</td>
<td>−0.11, 0.01</td>
<td>21</td>
<td>20,652</td>
<td>0.001</td>
</tr>
<tr>
<td>Hassles</td>
<td>0.01</td>
<td>−0.04, 0.06</td>
<td>5</td>
<td>1429</td>
<td>0.850</td>
</tr>
<tr>
<td>Perceived stress</td>
<td>−0.04</td>
<td>−0.06, −0.01</td>
<td>14</td>
<td>14,864</td>
<td>0.019</td>
</tr>
<tr>
<td>Appraised life events</td>
<td>−0.06</td>
<td>−0.13, 0.02</td>
<td>8</td>
<td>7874</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>European American participants</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–48%</td>
<td>−0.09</td>
<td>−0.12, −0.06</td>
<td>6</td>
<td>4275</td>
<td>0.790</td>
</tr>
<tr>
<td>59–65%</td>
<td>−0.07</td>
<td>−0.22, 0.08</td>
<td>6</td>
<td>1355</td>
<td>0.002</td>
</tr>
<tr>
<td>68–80%</td>
<td>−0.02</td>
<td>−0.14, 0.10</td>
<td>5</td>
<td>5520</td>
<td>0.047</td>
</tr>
<tr>
<td>84.5–100%</td>
<td>−0.04</td>
<td>−0.06, −0.01</td>
<td>5</td>
<td>6663</td>
<td>0.324</td>
</tr>
<tr>
<td><strong>Primiparous/primigravid participanrs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–30%</td>
<td>−0.07</td>
<td>−0.10, −0.03</td>
<td>5</td>
<td>3229</td>
<td>0.136</td>
</tr>
<tr>
<td>32.5–50%</td>
<td>−0.06</td>
<td>−0.10, −0.03</td>
<td>6</td>
<td>3338</td>
<td>0.775</td>
</tr>
<tr>
<td>56–62%</td>
<td>0.03</td>
<td>0.01, 0.06</td>
<td>5</td>
<td>6414</td>
<td>0.501</td>
</tr>
<tr>
<td>64–100%</td>
<td>−0.06</td>
<td>−0.14, 0.02</td>
<td>5</td>
<td>782</td>
<td>0.289</td>
</tr>
<tr>
<td><strong>Study quality rating</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.09</td>
<td>0.01, 0.08</td>
<td>2</td>
<td>1645</td>
<td>0.259</td>
</tr>
<tr>
<td>4</td>
<td>−0.03</td>
<td>−0.09, 0.02</td>
<td>9</td>
<td>13,629</td>
<td>0.001</td>
</tr>
<tr>
<td>5</td>
<td>−0.08</td>
<td>−0.16, 0.01</td>
<td>13</td>
<td>5775</td>
<td>0.001</td>
</tr>
<tr>
<td>6</td>
<td>−0.04</td>
<td>−0.06, −0.02</td>
<td>10</td>
<td>10,101</td>
<td>0.751</td>
</tr>
<tr>
<td><strong>Study type</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case control</td>
<td>0.01</td>
<td>−0.01, 0.03</td>
<td>9</td>
<td>10,980</td>
<td>0.088</td>
</tr>
<tr>
<td>Cohort</td>
<td>−0.10</td>
<td>−0.19, 0.00</td>
<td>10</td>
<td>17,258</td>
<td>0.001</td>
</tr>
<tr>
<td>Prospective observational</td>
<td>−0.04</td>
<td>−0.08, 0.01</td>
<td>16</td>
<td>3085</td>
<td>0.017</td>
</tr>
</tbody>
</table>

Mean r = mean correlation weighted by sample size; 95% CI = 95% confidence interval of effect size; Q = significance of test of heterogeneity.
chronic stressors associated with factors such as racism and discrimination [8]. Another possibility is that ethnic minority women are more psychologically or physiologically vulnerable to the effects of stress, such as being more vulnerable to stress-induced immune functioning changes [8]. The percentage of primigravid or primiparous women in the sample also emerged as a moderator. Results supported that the relationship between psychosocial stress and negative perinatal outcomes was stronger in studies with fewer primigravid or primiparous women. One possibility is that multigravid women may be more vulnerable than primigravid women to experiencing significant stressors such as having to balance child care responsibilities with managing the demands of pregnancy.

Two methodological variables also emerged as moderators. First, study quality rating emerged as a moderator. The two studies included in the meta-analysis with the lowest quality rating found a weaker relationship between stress and perinatal outcomes than studies with higher quality ratings. Thus, these two lowest quality studies likely provided a biased estimate of the relationship between stress and perinatal outcomes. In addition, cohort studies found a stronger relationship between stress and perinatal outcomes than the other two study types. Cohort studies often compared extreme groups of women with regard to reported stress (e.g., those reporting no major stressful events to those reporting multiple recent major stressful events) and they also tended to focus on more serious negative life events. Comparing extreme groups would then be more likely to lead to a stronger estimate of the effect of stress on perinatal outcomes.

Limitations of the study should be noted. First, while efforts were made to obtain both published and unpublished studies as well as international studies, it is possible that a number of studies were not located (and studies not written in English were excluded). However, it should be noted that unpublished studies and studies published in languages other than English tend to report smaller effect sizes and therefore inclusion of these studies would unlikely strengthen the size of the relationship found between stress and perinatal outcomes [62]. It should also be noted that there was no evidence of publication bias in the sample. Similarly, some studies had to be excluded from the meta-analysis because they did not report sufficient information to calculate an effect size. However, most of these studies reported that the relationship between stress and outcomes were non-significant and thus inclusion of these studies would be unlikely to strengthen the size of the relationship found between stress and perinatal outcomes. Another limitation is that certain analyses could not be conducted due to a lack of power. For example, there were insufficient studies to examine potential moderators of the relationship between psychosocial stress and specific perinatal outcomes. In addition, more fine-grained analyses of certain moderators could not be conducted, such as examining the relationship between stress and perinatal outcomes separately for different ethnic groups.

Strengths of the current study should also be noted. First, cross-sectional and retrospective studies were excluded from the meta-analysis, reducing the likelihood of finding spurious relationships between constructs due to the biases that can occur in such study designs [12]. Also, nearly all the included studies assessed women recruited from prenatal clinics and hospitals, reducing the likelihood of selection bias being a factor. In addition, random effects models were utilised to reduce the likelihood of making type I errors, and several analyses were conducted to evaluate potential bias in the studies identified (e.g., examination of publication bias, identification of outliers). Another strength of the current study is the number of analyses of potential moderators of the obtained effects conducted including analyses of methodological variables (e.g., study quality, type of study, type of stress assessed, type of pregnancy outcome) as well as individual difference variables (e.g., ethnicity, parity). Analyses of such potential sources of heterogeneity are key, given the limitations inherent in non-experimental research [12].

Findings have a number of implications for future research. First, results suggest that the experience of psychosocial stress alone has a negligible to at best a very small impact on a woman's risk for negative perinatal outcomes and that the stress likely needs to be of a very severe intensity to significantly affect perinatal outcomes. Thus, future research should instead focus on other psychosocial and lifestyle factors that are likely to have a stronger impact on risk for negative outcomes. Some examples of factors that may be more strongly associated with risk for negative outcomes include high levels of physical strain (such as performing demanding manual labour), inconsistent attendance at prenatal care visits, experiencing abuse during pregnancy, and having a serious psychiatric disorder during pregnancy [63–67]. Alternatively, it may be that psychosocial stress alone has a negligible impact on outcomes, but instead psychosocial stress may interact with other biomedical and psychosocial risk factors in increasing women's risk for negative outcomes. Thus, future research should also focus on whether psychosocial stress may serve to increase risk for negative perinatal outcomes among those women who already have a number of other biomedical and psychosocial risk factors. Research in these areas is imperative to develop a better understanding of women's risk for negative perinatal outcomes and ultimately lead to effective interventions to improve pregnancy outcomes for all women.

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Current knowledge on this subject

- Biomedical factors only explain about 50% of the variability in negative perinatal outcomes, suggesting that psychosocial factors may explain some of this variability.
- A number of pathways have been proposed whereby psychosocial stress may affect risk for perinatal outcomes including behavioral, neuroendocrine, and immune pathways.
- Prospective empirical investigations examining the relationship between psychosocial stress and negative perinatal outcomes have had mixed results, but also have varied greatly in their methodology.

What this study adds

- The current study is the first meta-analytic review of the association between psychosocial stress and negative perinatal outcomes.
- The current study supports that based on extant research the overall relationship between psychosocial stress and risk for negative perinatal outcomes is very modest at best.
- The current study identifies potential important moderators of the relationship between psychosocial stress and negative perinatal outcomes including the outcome assessed, severity of the stressor, ethnic minority status, and gravidity/parity.