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Are prenatal psychological or physical stressors associated with suboptimal outcomes in neonates born to adolescent mothers?

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Abstract

Examined whether prenatal psychological stress and/or physical stress were associated with suboptimal neonatal outcomes in a pilot study of adolescent mothers ($n = 20$). The results provide preliminary support for associations between prenatal psychological stress and little evidence for the association between prenatal physical stress and suboptimal neonatal outcomes.

There is an association between young maternal age and adverse developmental outcomes for infants [1]. Although difficult socioeconomic conditions, which adolescent mothers typically experience, appear to be partly responsible for the increased number of health, educational, and behavioral problems seen in children of adolescent mothers, these environmental stressors do not fully account for the observed variance in developmental outcomes [2]. In the context of increasing evidence of the role of fetal programming in disease susceptibility later in life [3], we hypothesize that psychological and physical stressors experienced during pregnancy that are associated with young maternal age play a role in conferring risk for adverse developmental outcomes, and that the adverse developmental trajectory begins with suboptimal neonatal outcomes. The goal of the present study is to explore whether psychological and/or physical stressors are associated with neonatal outcomes, which could potentially be the earliest point in a developmental trajectory during which meaningful individual differences may be observed.

With regard to physical stressors, young mothers who are still growing themselves may compete with their fetus for nutrients, meaning that nutritional deprivation in young mothers may hinder fetal development more significantly than similar deprivation in older mothers [4]. Changes in the circadian rhythm of sleeping habits during adolescence often results in sleep deprivation [5], which also may negatively impact the fetus. Stress and depression during pregnancy are also associated with poor infant outcomes [6], and this type of psychological stress increases from preadolescence to adolescence, especially among females. There is also evidence that depressed adolescents are more likely to become pregnant [7]. On the other hand, pregnant adolescents under stress may eat poorly, sleep little, and be more likely to develop infections [8], and it may be these physical behaviors associated with psychological stress, but not the psychological stress itself, that negatively affects fetal development.

A few prospective studies in humans have demonstrated negative effects of prenatal stress on outcomes in the offspring. Perceived stress during pregnancy was positively associated with maternal report of difficulty and observed problems with attention at 3 months of age [9].

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In another study maternal anxiety during pregnancy was associated with higher cortisol levels in the offspring when the subjects were 10 years of age [10]. Because little information about the fetal experience of the uterine environment can be assessed in humans, the neonate's status after birth is viewed as a potential window into fetal experience. Neonatal factors such as birth weight likely reflect more distal influences on the fetus, whereas meconium stained amniotic fluid may reflect more recent experiences.

The goal of the present study is to test the relative contribution of physical and psychological experiences of pregnant adolescents to neonatal outcomes. One way in which young maternal age may confer risk to the offspring is via an altered uterine environment within which set points and patterns of responding to may be established. The uterine environment of an adolescent differs from that of an older female in terms of the physical and psychological stressors noted above. If that is the case, then it is possible that the fetus/neonate of an adolescence mother is at higher risk for alterations in the structure, neurophysiology, or neurochemistry of certain brain regions that have long lasting impact on behavioral and emotional functioning. The neonatal outcomes that we assess in the present study (birth weight, Apgar scores, cord complications, and meconium staining of amniotic fluid) may be among the first observable individual differences that result from a compromised uterine environment and signal a sub-optimal developmental trajectory.

Methods

Participants

Pregnant adolescents who were in the latter part of the third trimester were recruited from a specialty teen OB/GYN clinic at the University of Chicago Hospital. The University of Chicago Institutional Review Board approved all study procedures. Over a period of 11 weeks, a research assistant approached adolescents who were identified by nurse practitioners as eligible for the study. The only inclusion criterion was an age between 15 and 18. A pregnancy that was medically complicated (e.g., premature labor, placenta previa) was the only exclusion criterion. A total of 20 adolescents were approached and 100% agreed to participate. The majority of adolescents (90%) identified themselves as African-Americans; one identified herself as Hispanic, and another as multiracial. All were Medicaid recipients. These demographics reflect the representativeness of the participants of this specialty clinic.

Eighteen of the adolescents completed the questionnaires during a scheduled prenatal visit in the last month of pregnancy and two completed them in the immediate post-partum period. There may be differences in the reporting of psychological and physical stressors during pregnancy and the immediate post-partum period that make the two reporting periods uncomparable. Because scores for these two participants did not differ significantly from the other participants, and excluding these participants did not change the results, we chose to retain these participants given the very exploratory nature of the study.

Psychological Stress

The *Beck Depression Inventory-II* (BDI-II) [11], the *Screen for Anxiety Related Disorders* (SCARED) [12], the *Life Events Checklist* (LEC) [13] were administered as well-validated measures of psychological stress. The BDI was used to assess depressive symptom over the past two weeks, which is the standard time frame [11]. Items on the SCARED are stated in present tense, which is the standard method of assessment, and include questions about trait-like qualities (e.g., I am a worrier), stimuli that elicit anxiety (e.g., I am afraid to be alone in the house), and somatic responses (e.g., when I get frightened I feel dizzy) [12]. The LEC is a list of significant life events (e.g., death of a close friend, parent losing a job) [13]; the adolescents reported whether the events had been experienced during pregnancy. Life events

questionnaires, which include relatively low base rate events, typically utilize assessment windows of at least several months.

Physical Stress

Sleep/wake problems during the past two weeks were assessed from the *Sleep Habits Survey* [14], which is validated for adolescents. The number of nutritional deficits below the estimated average requirement or adequate intake level for pregnant females ages 18 and under [15] for protein, fiber, calcium, iron, and vitamins A and C were derived from a *24-hour recall of nutritional intake*. *History of infection* during pregnancy was collected from the medical record.

Neonatal outcomes

Neonatal outcome measures included *Apgar scores*, which ranged from 7 to 9 (see Table 1), *birth weight*, *cord complications*, and *meconium staining*. Observed cord problems included nuchal or wrapped cords, and these were combined into a single variable. Similarly, thin or thick meconium staining was combined into a single variable.

Results

Scores for maternal psychological stressors were continuously and normally distributed. In terms of maternal physical stressors, the sleep problem score was continuously and normally distributed, number of nutritional deficits was treated as an ordinal variable and presence or absence of maternal infection during pregnancy was a dichotomous variable. Among the neonatal outcomes, birth weight was continuously but not normally distributed, Apgar score at 1 minute was treated as an ordinal variable, and cord complications and meconium staining were dichotomous variables. Non-parametric correlations (e.g., Spearman and Kendall's tau-b) were used to test for associations between continuous and ordinal independent measures and birth weight, ANOVA was used to test for associations between continuous independent measures and cord complications and meconium staining, and Chi Square analysis for testing associations between two dichotomous variables. Given the small sample size, which is not sufficiently powered to detect medium effect sizes, and the exploratory nature of the study, we report *p* values less than .10 and findings with medium effect sizes.

We first tested whether maternal psychological stressors were associated with neonatal outcomes. Depressive symptoms were statistically significantly associated with meconium staining ($F [1,18] = 4.85, p < .05, \eta^2 = .22$), but not with birth weight (Spearman = .13, $p > .10$), cord complications ($F [1,18] = 0.03, p > .10, \eta^2 = .04$) or Apgar scores (Kendall's tau-b = $-.06, p > .10$). The average score on the BDI for the adolescents whose amniotic fluid was meconium stained was 17.6 (95% CI = 12.4 – 22.8) compared with 9.4 (96% CI = 5.6 – 13.2) for those with clear amniotic fluid (see Figure 1). Number of negative life events was marginally significantly associated with cord complications ($F [1,18] = 3.11, p < .10, \eta^2 = .38$), but not associated with meconium staining ($F [1,18] = 0.9, p > .10, \eta^2 = .22$), birth weight (Pearson $r = .08, p > .10$), or Apgar scores (Kendall's tau-b = $-.06, p > .10$). The average number of negative life events for the five adolescents whose neonates experienced cord complications was 4.4 (95% CI = 2.3 – 6.5) versus 2.4 (95% CI = 1.2 – 3.6) for those without cord problems. Anxiety symptoms were not statistically significantly associated with any neonatal outcome.

Next we tested the association between maternal physical stressors and neonatal outcomes. None of the physical stressors were associated with birth weight, Apgar scores, or meconium staining, nor were any of the effect sizes in the medium range. None of these tests were statistically significant. There were two notable non-significant trends for the effect of physical stressors on cord complications. First, of the 5 neonates who experienced cord complications, 4 (80%) had mothers who reported 3 or more nutritional deficits, which is above the mean for

the sample, in comparison to 8 (53.3%) of the mother of neonates without cord problems who had 3 or more nutritional deficits. Second, the average sleep problems score was 27.0 among mothers of neonates with cord complications compare to 21.1 for mothers of neonates without cord complications. Although this comparison was not statistically significant ($F[1,18] = 1.86$, $p > .10$, $\eta^2 = .31$), a score of 27 represents an increase of .5 of a standard deviation above the mean of the sample for sleep problems among those mothers whose neonates experienced cord problems.

Discussion

Young maternal age is associated with poor developmental outcomes in offspring, but the mechanism by which risk is conferred is not known. In the present study we aimed to explore whether psychological and/or physical stressors during pregnancy were associated with neonatal outcomes. The rationale for exploring these hypothesized correlates is that there are changes in psychological and physical stressors from preadolescence to adolescence. Thus, adolescent-onset changes in these behaviors may contribute to increased risk among offspring of adolescent mothers.

Our results provide preliminary support for a direct association between maternal psychological stressors and neonatal outcomes, with depressive symptoms explaining variance in meconium staining of amniotic fluid, and negative life events being associated with cord complications. There was some indication that nutritional deficits and sleep problems may be slightly increased among mothers whose neonates experienced cord complications, but these tests did not reach the level of statistical significance. These findings suggest that it is more likely that psychological stress itself, and not the physical sequelae from the stress, impacts the fetus resulting in the sub-optimal neonatal outcomes observed in this study. It is possible that psychological stress interacts with physical stress to increase the risk of neonatal outcomes, such as the interaction of life events and nutritional deficits on cord problems. The small sample size of the present study, however, did not afford us the possibility of testing such interactions.

The passage of meconium and the presence of a knotted or wrapped cord both are indicators of stressful delivery experiences that can limit the oxygen supply or blood flow to the fetus. The fact that even subtle differences in maternal psychological experiences, such as mild depression or a higher number of life events measured at one point in time, explained some of the variance in sub-optimal neonatal outcomes is compelling. Even mild forms of depression and dysthymia are associated with increased levels of corticotropin-releasing factor and cortisol [16], and an increase of even one life event was associated with a 27% increase in evening cortisol during late pregnancy in a large population-based sample [17]. Thus, it is possible that the higher levels of depression and negative life events observed in the present study were associated with an altered hormonal environment for the mother and the fetus, which in turn resulted in sub-optimal neonatal outcomes. Moving beyond the limitations of the current study by increasing the sample size, the frequency of assessments, and covering each of the three trimesters is likely to yield more useful data for determining the importance of the timing of stressors, the potential interactive effects of psychological and physical stressors, and for proposing hypothesized mechanisms by which stress during pregnancy affects the fetus and neonate.

Assuming that psychological stressors do play a role in increasing the probability of sub-optimal neonatal outcomes, the next question is whether pregnant adolescents are more likely to experience psychological stress than older pregnant women. If so, then the link between poor outcomes in the offspring and young maternal age may be explained by the higher rates of psychological stress (e.g., depression) among adolescents. In the present sample, 4 (20%) of the pregnant adolescents had BDI-II scores at or above 14, which are scores in the mildly

to moderately depressed range. Similar rates have been reported in samples of older pregnant women of the same race and from a similar socioeconomic environment [18,19]. Therefore, it is unlikely that higher rates of psychological stress explain the greater risk to offspring of young mothers. An alternative explanation is that some other adolescent-specific variable interacts with psychological distress to lead to suboptimal outcomes in the offspring. One possibility is that normative increases in basal cortisol during adolescence [20] in the context of excess levels of circulating cortisol due to psychological stress may create a fetal environment marked by excess glucocorticoids. Further research is needed to expand on the current findings and explore more complex models of the mechanisms by which young maternal age leads to less optimal outcomes in the offspring.

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Figure 1.

Association between BDI-II scores and thin or thick meconium staining of amniotic fluid: $F[1,18] = 4.85$, $p < .05$, $\eta^2 = .22$.

Descriptive statistics for maternal psychological and physical stressors, and neonatal outcomes

Maternal Psychological Stressors	Mean	(SD)	Range	N	%
Depression (BDI-II)	11.5	6.8	0 – 28		
Anxiety (SCARED)	15.5	7.7	5 – 33		
Negative life events (LEC)	2.9	2.3	0 – 9		
Maternal Physical Stressors					
Sleep problems	22.6	8.6	13 – 48		
Nutritional deficits	2.9	1.5	0 – 5		
Infection during pregnancy				11	55.0
Neonatal Outcomes					
Birth weight	3185.5	340.7	2395 – 3860	5	25.0
Cord complications				7	35.0
Meconium staining					
Apgar at 1 minute				10	50.0
9				8	40.0
8					
7				2	10.0

Note: BDI-II = Beck Depression Inventory-II; SCARED = Screen for Anxiety Related Disorders; LEC = Life Events Checklist; Nutritional deficits = number below the estimated average requirement or adequate intake for pregnant females 18 or younger according to the Dietary Reference Intakes.