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Healthy Beginnings: Exploring the Impact of Parental Stress and Relationship Quality on Birth Outcomes

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Exploring the impact of parental stress and relationship quality on birth outcomes

By

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Abstract

Healthy Beginnings:
Exploring the impact of parental stress and relationship quality on birth outcomes

By

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This dissertation consists of three studies exploring the effects of maternal and paternal experiences of stress and perceptions of relationship quality on length of gestation and birth weight. The first study assessed the association of parental relationship quality with the baby's length of gestation and birth weight among 2,072 families in the Fragile Families and Child Wellbeing study. Romantic relationships can be a substantial source of social support as well as stress, and have been shown to influence many health outcomes. Beyond crude relationship characteristics, however, few studies have assessed the association of other dimensions of relationship quality, such as conflict and support, with birth outcomes. No studies have assessed the association of father's report of relationship quality with birth outcomes. In this study, multilevel linear regression analyses found that babies born to fathers who were present at their birth were born significantly heavier and had a longer gestation. The results also showed that greater paternal relationship conflict was associated with lower gestational age among all couples and lower birth weight among unmarried couples.

The second study investigated the association between parental stress during pregnancy with their baby's length of gestation and birth weight among a sample of 270 young couples in southern Connecticut. Many studies have shown that women's experiences of stress during pregnancy are associated with preterm birth and low birth weight; however, men's experiences have largely been ignored. Structural equation modeling of the association between maternal and paternal stress latent

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variables and birth outcomes showed that greater paternal stress was significantly associated with longer gestation and greater birth weight, while maternal stress was not significantly associated with these outcomes. The findings from the first two studies suggest that men's experiences and feelings when they are expecting a baby may have a unique contribution to birth outcomes.

The third study assessed the association between parental stress during pregnancy and their own and their partner's poor health behaviors and depressive symptoms among a sample of young couples in lower Connecticut. Many unhealthy behaviors, such as substance use, develop during adolescence and evidence shows that stress is a contributing factor. This association has not been established among pregnant adolescents and little attention has been paid to male partners. Among a sample of 294 young expectant couples, multilevel modeling showed that one's own experiences of stress were associated with more unhealthy behaviors and depressive symptoms for both members of the couple. Cross-over effects were also evident—paternal stress was predictive of more maternal conduct problems, while maternal stress was predictive of less paternal substance use and more depressive symptoms. These findings highlight the importance of social relationships and interactions on health behaviors.

Overall, the results of the three studies suggest that father's experiences during pregnancy matter to their baby's health, and that experiences of stress during pregnancy may impact an expectant couples' own and their partner's health behaviors. This dissertation research treated men's experiences during pregnancy, including experiences of stress and relationship quality, with equal weight to women's experiences when it came to their impact on birth outcomes and health behaviors. Future, research, programs and policies aimed at improving birth outcomes may be strengthened by the inclusion of expectant fathers.

Dedication

To Lydia, for giving me strength and perspective.

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Mom and Dad, both by example and through your parenting, you taught me that through hard work and persistence I could achieve whatever I set my mind to (besides a vocal career). Thank you for

sacrificing so that I could have opportunities to grow and challenge myself academically and athletically. It is through these experiences and with your unrelenting love and support that I had the opportunity to pursue and achieve this dream.

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Chapter I.   Introduction and Background

a. Overview and Specific Aims

This dissertation research aims to assess the impact of parental stress on birth outcomes. Despite substantial national prevention efforts, the rates of preterm birth (PTB) and low birth weight (LBW) are higher today than they were two decades ago in the United States (U.S.). These negative birth outcomes disproportionately affect minority populations, cost the U.S. hospital system over $16.8 billion annually and have health effects that persist into adulthood. Improvements in rates of traditional risk factors (e.g. smoking, prenatal care) have not corresponded to improved rates of PTB and LBW, suggesting that other factors are at play. Maternal stress during pregnancy is one such factor that is consistently associated with PTB and LBW. Research has focused on maternal stress and the influence of fathers has been ignored, despite increasing evidence that fathers play an important role in their children's health and development.

This research aims to assess the association of several dimensions of maternal and paternal stress with PTB and LBW, and the psychosocial pathways through which stress affects these outcomes. From a stress and coping framework, it also aims to assess how relationship quality is associated with PTB and LBW. This is the first research to assess the effect of direct report of paternal experiences of stress and relationship quality on birth outcomes. It is also the first research of its kind to use dyadic data analysis methods to parcel out the independent and interactive effect of each parent among couples—particularly among young couples who may be more susceptible to stress and its effects on birth outcomes.

The specific aims of this dissertation research are:

Aim 1: Assess the association of maternal and paternal reports of relationship quality with the gestational age at birth and birth weight of their baby among families in the Fragile Families and Child Wellbeing study.

Aim 2: Investigate the association between maternal and paternal stress during pregnancy with the gestational age at birth and birth weight of their baby among a sample of young couples in southern Connecticut.

Aim 3: Investigate the association between maternal and paternal self-reported stress during pregnancy and their own and their partner's negative health behaviors among a sample of young couples in southern Connecticut.

b. Stress and Preterm Birth and Low Birth Weight

b.1 Public Health Impact

Ensuring the health of our populations starts with ensuring the health of our children even as early as their development in the womb. Preterm birth (PTB; <37 weeks gestation) and low birth weight (LBW; <2,500 grams) are the leading causes of neonatal mortality in the United States (U.S.) today.[1] More than one in 1,000 live births result in infant death due to disorders related to short gestation and low birth weight.[2]   Alarmingly, the rate of preterm birth has increased by 21% since 1981 despite substantial national prevention efforts.[3] In addition, every Healthy People initiative since the program's inception in the 1970s has included the goal of reducing the rates of LBW;[4–7] however, the 2013 rates of PTB (11.38%) and LBW (8.02%)[8] were over 50% higher than the 2010 Healthy People target rates of 7.6% and 5.0%, respectively.[4]

The costs of preterm birth and low birth weight are substantial to both individuals and society. Infants born preterm are at greater risk for neonatal morbidity, such as temperature instability, respiratory distress, feeding difficulties, jaundice and Periventricular Leukomalacia (death of white brain matter).[9,10] Evidence also shows that children born preterm and/or with a low birth weight continue to be at an increased risk for developmental delay[11] and behavioral problems during childhood.[12] These same infants are also at increased risk for chronic medical and social disabilities into adulthood, such as cerebral palsy,[13] major psychological disabilities,[13] asthma[14] and cardiovascular problems.[15]

The financial costs of preterm birth and low birth weight are also massive. The average cost for a very pre-term baby is over $190,000 for medical care in the baby's first year alone.[16] As a society, total costs for medical care resulting from preterm birth exceed $16.8 billion annually in the U.S. alone (in 2005 U.S. dollars). This figure does not include the substantial long term educational and productivity costs to individuals and society as a whole.[16] When including early childhood medical care costs, early

intervention services, special education and household and labor market productivity losses due only to the four most common conditions associated with preterm birth, the cost estimate exceeds $26 billion in 2005 U.S. dollars[16] and has likely escalated since.[17,18]

b.2 Rationale for exploring stress as a contributor to PTB and LBW

Researchers have searched for many years to identify potential targets for interventions to reduce the rates of preterm birth and low birth weight in the U.S. Smoking and access to prenatal care, for example, have long been shown to affect birth outcomes on an individual level.[19,20] On a population level, however, while we have successfully reduced rates of smoking during pregnancy and improved access to and use of prenatal care, the rates of PTB and LBW continue to remain high despite these improvements. For example, between 1990 and 2002, the rates of preterm birth and LBW in the U.S. both increased by about 15%,[21] while the rates of maternal smoking declined 38% during this same time period.[22] Other researchers have hypothesized that high rates of negative birth outcomes may be due to changing demographics of childbearing (e.g. increased maternal age and use of assisted reproductive technologies leading to more multiple births) and changes in obstetrical interventions, which have led to more pre-term C-sections and a lower intrauterine fetal death rate.[23–25] These factors certainly contribute to but do not completely explain the high rates of PTB and LBW.[25]

In an effort to identify other potential underlying causes of PTB and LBW, researchers have been exploring the role of maternal stress for many years. The hypothesis that a woman's psychological state during pregnancy may affect the health of her baby dates back to Hippocrates;[26] however, the first published studies defining a link between maternal stress and birth outcomes emerged in the 1950s and research has intensified in the last 40 years.[27] The general premise is that stress causes physiological

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and behavioral changes in the pregnant mother that impact the developing fetus and the timing of parturition.

Indeed, greater maternal perceived stress has been associated with physiological changes in the pregnant mother, such as increases in cortisol and cytokine production, which are both thought to play a role in fetal growth and parturition.[28–30] Epidemiological evidence also shows that maternal stress during pregnancy is consistently predictive of negative birth outcomes, including PTB[27,28,31–33] and LBW.[27,31,34,35] The epidemiological evidence, which is discussed in greater detail later in this chapter, varies greatly in the study designs, populations and methodology employed; however, it appears that the size of the effect of maternal stress on PTB and LBW is equivalent to that of other well-established risk factors (e.g. sociodemographic and behavioral factors) for PTB and LBW.[36] In fact, based on the existing evidence, the American Congress of Obstetricians and Gynecologists recommends screening for psychosocial stress as part of prenatal care, citing that it may play a role in PTB and LBW.[37]

Certain U.S. populations are disproportionately affected by severe and chronic stressors and are at increased risk for PTB and LBW. For adolescents and young adults who are racial and/or ethnic minorities, live in urban areas and are from a low socioeconomic status (SES), daily stressors often extend beyond these typical developmental challenges. This population is disproportionately affected by other more severe and chronic stressors, such as neighborhood problems, racism and discrimination.[38] Teen mothers in the U.S. are more likely than older mothers to give birth prematurely and/or have a baby with a low birth weight. In 2013, just under 13% of mothers age 15-19 gave birth preterm (PTB) compared to 10.8% of mothers age 20-34. Additionally, 9.3% of mothers age 15-19 had a baby with a LBW compared to 7.7% of mothers age 20-34.[39] Non-Hispanic black mothers were also more likely than white mothers to have a baby with PTB (16.3% vs. 10.2%) and LBW (13.1% vs. 7.0%).

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b.3 Current Prevailing Conceptual Model and Pathways

Stress is an interactive process in which environmental demands exceed one's adaptive capacity, resulting in psychological and physiological changes that can lead to poor health outcomes.[40] The stress process is characterized by three major components: a stressor, an appraisal or perception of the stressor, and a response.[41] Stressors can interact with a person's psychological state, disposition, social support, genetics, as well as their social and environmental context.[42]

Dunkel-Schetter and Lobel[43] offer the most comprehensive framework depicting the pathways through which maternal stress may influence PTB and LBW (Figure I-1). The conceptual model describes how both chronic (persistent or recurrent difficulties over the long term) and acute (discrete threats that are shorter term) stressors can influence birth weight and gestational age at delivery. Dunkel-Schetter and Lobel's framework synthesizes findings from a large literature examining individual stress components and birth outcomes. Previous studies, however, have been inconsistent in terms of how stress is conceptualized, if a conceptual model is attended to at all, and no studies have assessed all components of this model, including stress exposures, appraisal, responses and birth outcomes.
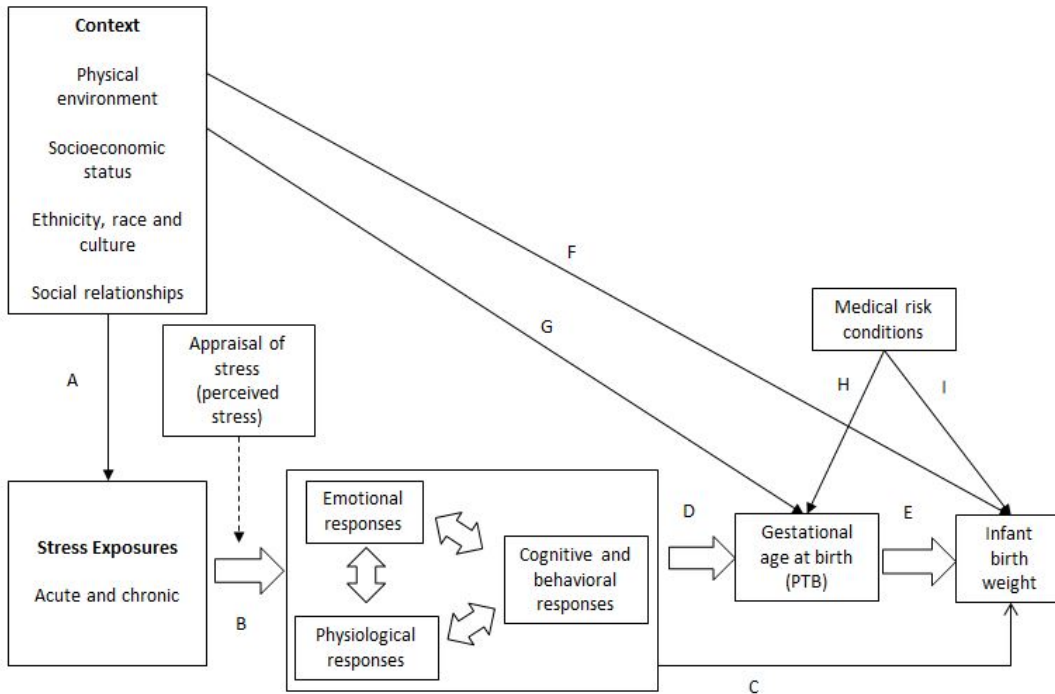
Figure I-1. Conceptual model of stress and birth outcomes. Reproduced from Pregnancy and Birth Outcomes: A multilevel analysis of prenatal maternal stress and birth weight. In: *Handbook of Health Psychology (2nd Edition)* (p.451), by Dunkel-Schetter and Lobel, 2012, New York: Springer.[43]

As depicted in Dunkel-Schetter and Lobel's (2012) model above,[43] the three most commonly hypothesized pathways through which stress affects birth outcomes include behavioral, emotional and physiological responses, which are all interrelated.[43,44] Each of these pathways is described below.

Behavioral Responses

Studies have shown that stress consistently predicts negative health behaviors (e.g. smoking, substance use, dietary habits, physical activity) among both non-pregnant[28,45] and pregnant women.[43,46] These negative health behaviors, which may serve as stress coping mechanisms,[41] are consistently related to adverse birth outcomes. For example, smoking and substance use (cocaine in particular) are

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well-documented predictors of PTB,[19] and inadequate nutrition and smoking are risk factors for LBW.[20,43]

Few studies have assessed the full mediational pathway of stress, health behaviors and birth outcomes.[35] One study among an ethnically diverse sample of women, used structural equation modeling (SEM) to show that pregnancy-specific stress (e.g. feeling bothered, worried or upset by whether you might have an unhealthy baby; or paying for the baby's clothes, food or medical care) was not directly related to birth weight, but was predictive of cigarette smoking (unstandardized B=0.22) and cigarette smoking was inversely related to birth weight (unstandardized B=-0.15).[47] In the same study, pregnancy-specific stress was directly predictive of gestational age (GA) at birth (unstandardized B=-0.18) and this association did not change when accounting for smoking.[47] This study suggests that stress may have both a direct physiological effect on birth outcomes and an indirect effect through health behaviors, particularly smoking.

Emotional Responses

Lazarus (2000) described how there are at least fifteen emotions that can result from stress, including sadness, shame and anxiety.[48] These emotions can result from negative appraisals or perceptions of stress. Epidemiological literature shows that stress is consistently associated with increased depressive symptoms among both men and women,[49] and among pregnant women.[50] As Figure I-1 depicts, depressive symptoms may affect both behavioral and physiological responses, and ultimately risk for negative physical health outcomes (Figure I-1),[40] including reproductive health outcomes.

A 2010 meta-analysis of 29 published studies showed that women with depression during pregnancy are at a modest, but statistically significant, increased risk for PTB, LBW and intrauterine growth restriction (IUGR).[51] This meta-analysis estimated that the relative risks increased by 39%-49%

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depending on the outcome. To put the magnitude of the effect of major depression or clinically significant depressive symptoms on birth outcomes in perspective, this increase in risk for PTB and LBW is comparable to the increased risk for PTB posed by smoking ten or more cigarettes per day.[52,53]

Physiological Responses

Neuroendocrine

While the relationship between stress and negative birth outcomes has been studied for decades, the precise physiological pathways remain poorly understood.[29] The majority of studies, using both animal and human models, have focused on the endocrine system, and specifically the hypothalamic-pituitary-axis (HPA), which regulates the physiological response to stress through the release of glucocorticoids such as cortisol. This mechanism can become dysregulated under conditions of chronic stress, leading to chronically elevated levels of cortisol in the system.[28]

In pregnant women, the HPA axis is altered to protect the development of the fetus. The secretion of cortisol *stimulates* the secretion of other glucocorticoids in pregnant women, while in the non-pregnant state cortisol shuts off the production of more glucocorticoids.[29] A premature surge of glucocorticoids, which could result from environmental stress, can enter fetal circulation and cause a series of endocrine events, leading to PTB.[28] Evidence demonstrates that elevated levels of corticotropin-releasing hormone, a glucocorticoid involved in the HPA-axis stress response, predicts spontaneous preterm birth, even when controlling for traditional obstetric risk factors.[30] The physiologic pathway between stress and LBW (that is not due to PTB) is less clear; however, evidence from animal studies show that exposure to glucocorticoids, even in short duration, can reduce fetal growth. Studies have shown anywhere between 15%-32% reduction in size across sheep, monkey, rat, mice, and rabbit models, with the effect varying by frequency and quantity of exposure, and animal model.[54,55]

<u>Immune System</u>

The endocrine system also interacts with the immune system,[56] and research shows that psychosocial stress affects immune responses in both non-pregnant humans and animals.[29] Unlike in non-pregnant humans, women's immune systems are altered during pregnancy.[29] Despite important changes in immune system function during pregnancy, little research has examined the role of the immune system in mediating the relationship between stress and fetal development.[29,57] In a recent review of studies linking stress and circulating inflammatory markers (part of the immune response), Christian and colleagues reported only one small study by Coussons-Read et al. (n=24) measuring this association, which found that perceived stress was associated with higher circulating levels of pro-inflammatory cytokines and lower levels of an anti-inflammatory cytokine among pregnant women in the late first/early second trimester.[58] Christian et al. reported two other studies, one by Ruiz et al. reporting crude differences and one by his research group controlling for pre-pregnancy BMI, both demonstrating that depression was associated with higher circulating levels of pro-inflammatory cytokines.[59,60]

There are several hypothesized pathways through which stress may affect birth outcomes through the inflammatory/immune response. An inflammatory response may trigger preterm delivery by causing preterm contractions, cervical ripening and membrane rupture.[29] Inflammation may also cause hypertension and subsequently preterm birth.[29] Further, stress may increase maternal susceptibility to infection, which can initiate preterm delivery.[27] One such infection, bacterial vaginosis, has been linked to greater risk for spontaneous preterm delivery.[61] The release of catecholamines (an inflammatory response) may also decrease the amount of nutrients the fetus receives and ultimately reduce fetal growth.[28]

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b.4 Paternal experiences of stress and their influence on birth outcomes

A large body of literature, described above, has documented that women's experiences of stress during pregnancy are associated with negative birth outcomes;[27,28,31–34,43] however, research has also demonstrated that the perceptions of stress and coping strategies are affected by social relationships.[62] The relationship with the baby's father is often an important social relationship in an expectant woman's life. While an increasing number of mothers are not married when their child is born, over 80% of unmarried women are in a relationship with the baby's father during pregnancy,[63] even among adolescents.[64,65] Thus, a woman's male partner—married or not—is usually an important social relationship during pregnancy and he likely has a substantial influence on the expectant mother during this time.

Despite the importance of male partners during pregnancy, very little research has explored paternal influences in general on birth outcomes.[66] Figure I-2, adapted from Misra (2010),[67] depicts the hypothesized pathways through which paternal factors can influence birth outcomes. Research that has assessed paternal influences on birth outcomes has narrowly focused on paternal demographic characteristics, occupational exposures and "paternal involvement," each of which is most often reported by the mother, introducing concerns about measurement error. A 2010 review by Shah et al. identified 38 studies assessing several paternal factors (age, height, BMI, birth weight, occupation, education and alcohol use) and risks for PTB, LBW and small for gestational age (SGA).[66] Of the eight paternal factors, only three were consistently associated with birth outcomes: extreme paternal age (<20 and >40) was consistently associated with greater risk for LBW, but not consistently with PTB and SGA; greater paternal birth weight consistently predicted greater infant birth weight; and greater paternal height was associated with greater infant birth weight.[66] All of these factors are hypothesized to act through the germ cell line and, thus, through Path a depicted in Figure I-2. Shah's review presents

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a rather limited conceptualization of the types of paternal factors that have been considered as contributors to birth outcomes.
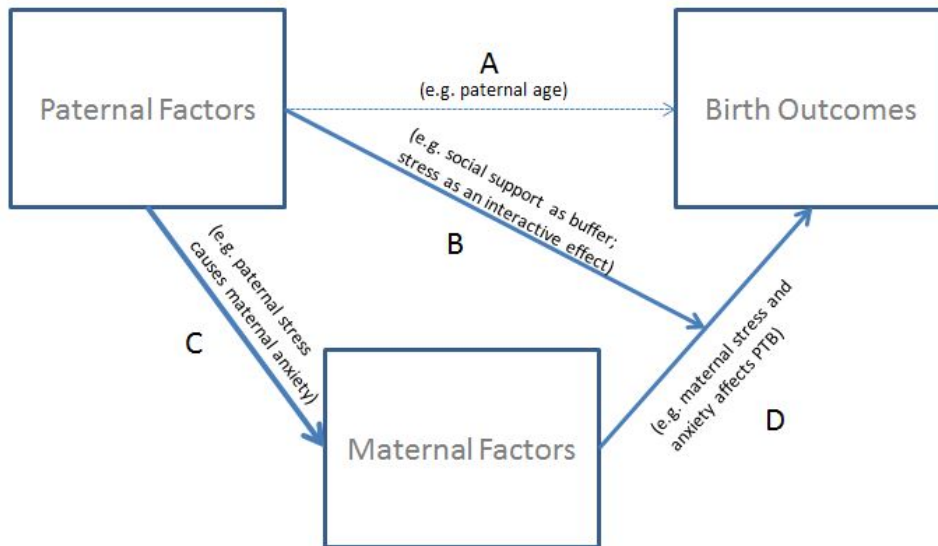
Figure I-2. Conceptual framework of pathways of paternal influence on birth outcomes. Adapted from "Do fathers matter? Paternal contributions to birth outcomes and racial disparities" by D.P. Misra et al. 2010, *American Journal of Obstetrics & Gynecology 202*(2),p.100.[67] Thick lines indicate pathways of interest in this dissertation.

Research examining the impact of maternal stress on birth outcomes that *has* included paternal

factors has been limited to *maternal reports* of paternal involvement and support, with the premise that

paternal involvement and support reduces maternal stress during pregnancy, thus decreasing the risk

for negative birth outcomes.[68] More involved fathers may provide more social support, which has been

demonstrated to be an independent predictor (as reported by the mother) of positive birth outcomes,

as well as a buffer of the relationship between stress and negative birth outcomes.[69,70] This research is

based on the hypothesized pathway depicted by lines B and D in Figure I-2. There is, however, concern

about measurement error when we rely solely on maternal report of paternal factors. There could be a

large discrepancy between maternal and paternal report of paternal social support. Maternal report of

paternal factors may be more tied to her own psychological state than the true actions of her partner.

In support of the premise that paternal involvement and support can affect maternal

psychological health and thus birth outcomes, Alio and colleagues (2010) reviewed seven published

studies and found that paternal involvement (measured in various ways across studies) was consistently

related to a reduction in the risk for LBW and SGA, in addition to more positive maternal prenatal health

behaviors (which may mediate the relationship between paternal involvement and birth outcomes).[68] In

addition, a retrospective case-control study of over 2,200 singleton births to mostly Latina women in Los

Angeles showed that women with moderate to high partner support during pregnancy (maternal report

of how much the baby's father showed he cared for her, did not criticize her and supported her

financially during pregnancy) had lower odds of PTB compared to women with low partner support

adjusted for several sociodemographic and behavioral factors (aOR=0.73, 95% CI 0.52, 1.01).[71] The

retrospective report of partner support however, may be biased by the pregnancy outcome, thus

inflating the effect estimate of partner support on PTB. Further, the measures of paternal involvement

and support, however, are often crude (e.g. father's name on birth certificate) and reported by the pregnant mother.[68,71]

Men's experiences of stress during his partner's pregnancy may also influence birth outcomes through his effects on maternal psychosocial factors.[67] This pathway is depicted by lines C and D in Figure I-2 below. In fact, substantial evidence supports the theory that among couples, stress experienced by one member can cross-over and affect the well-being of the other member.[72] For example, a woman's partner's stress with his friends may cross-over and impact her own depression.[72] The closeness of a couple may also moderate the cross-over effect, with closer couples experiencing more cross-over of the effects of stress from one member to the other.[73] Much of this research has focused on the cross-over of one's work stress to the other's well-being[72] and relationship satisfaction (e.g. Neff[74]); however no studies have documented this process among expectant couples, and none have assessed the impact of paternal stress during pregnancy on birth outcomes via effects on maternal well-being.

b.5 Epidemiological Evidence

Preterm Birth

Some recent reviews of the epidemiological literature demonstrate that higher levels of maternal stress predict PTB.[27,28] In Beydoun and Saftlas' 2008 review, nine of eleven human studies found an association between prenatal stress and length of gestation, preterm labor or preterm birth.[27] Littleton's 2010 meta-analysis found that psychosocial stress was not significantly associated with risk for PTB across 13 studies (crude *r* (13)= .04; 95% CI=-0 .03, 0.11).[75]

More recent studies have reported evidence supporting the association between stress and PTB. A prospective cohort study of 1,800 married Chinese women delivering after 32 weeks gestation found that the women reporting the highest levels of severe stressful life events in the first (aRR=2.40; 95% CI 1.13, 5.09) and second trimesters (aRR=2.86; 95% CI 1.26, 6.47) were more likely to experience PTB than women with no life event stress during that time, adjusting for maternal age, education, income, social support, negative coping and infant gender.[31] Women in this study reported on the events in one survey conducted after their third trimester clinical visit referring to events occurring in all trimesters.[31] This method is not truly prospective and there may be measurement error due to the misclassification of the timing of the events. A different prospective cohort study of 415 pregnant English-speaking women from Los Angeles reported that an increase in perceived stress between assessments at 18-20 weeks and 30-32 weeks gestation was a significant predictor of preterm birth when adjusting for race and parity (aOR=3.08; 95% CI 1.51, 6.28).[32] Further, in a Danish population-based study, the burden of life stress (B=-0.14; 95% CI -0.19, -0.10) and emotional symptoms (e.g. anxiety, nervousness) (B=-0.04; 95% CI -0.07, -0.004) during pregnancy assessed around 30 weeks gestation significantly predicted fewer days of gestation after adjusting for maternal age, socioeconomic status, infant gender, pre-pregnancy body mass index, parity, hypertension, diabetes, and smoking.[33]

Low Birth Weight

The epidemiological evidence supporting the association between stress and LBW is less consistent than the evidence supporting the association with PTB.[28] Low birth weight can result from being born early, from growth restriction in the womb, or both.[43] Thus studies vary in whether they assess crude birth weight and low birth weight (regardless of GA), birth weight adjusted for GA, small for gestational age (SGA), and intrauterine growth restriction (IUGR). The latter two measures are assessments of whether the baby weighs less than 90% of other babies at the same GA.[76]

Beydoun and Saftlas (2008) report that of ten studies, nine identified a significant negative association between prenatal stress and birth weight or fetal growth restriction, most controlling for several important confounders, but not all adjusting simultaneously for maternal age, race/ethnicity, SES, smoking and infection.[27] Littleton's meta-analysis found that psychosocial stress was significantly associated with neonatal weight in 14 studies, (crude *r*= -.07; 95% CI=-.13, -.01) and with low birth weight in 5 studies (crude *r*= -.07; 95% CI=-.03, -.10).[75]

More recent studies have reported less consistent results. Zhu and colleagues (2010), in a study of 1,800 married Chinese women delivering after 32 weeks gestation, found that the perceived impact of severe stressful life events experienced in the first trimester only (reported in one survey after their third trimester clinical visit assessing events in all trimesters) predicted lower birth weight (B=-99.09; 95% CI -137.98, -60.20).[31] Tegethoff, in a study of a Danish population-based birth cohort, alternatively found that the burden of life stress during pregnancy assessed at about 30 weeks gestation significantly predicted an *increased* birth weight adjusted for GA, maternal age, socioeconomic status, infant gender, pre-pregnancy body mass index, parity, hypertension, diabetes, and smoking (z-score, B=9.14; 95% CI 4.99, 13.28). Emotional symptoms (e.g. anxiety, nervousness) were not significantly predictive of birth weight adjusted for GA in this study.[33] In another study of 294 low-income women delivering in nine

Illinois counties, Bryant Borders et al. (2007) reported that several psychosocial factors, including food insecurity (aOR=2.6, 95% CI 1.7,3.5), having a child with a chronic illness at home (aOR=3.1, 95% CI 2.3,4.0), being unemployed (aOR=3.7, 95% CI 2.7,4.7) and poor coping skills (aOR=4.0, 95% CI 3.1,4.9) significantly predicted low birth weight after adjusting for maternal age, while social support, depression and perceived neighborhood safety were not significantly related to low birth weight.[34] Notably, food insecurity may not only be measuring the effect of a stressor on the birth outcome—not having enough food can also directly affect fetal growth by affecting the caloric and nutritional substrate available to the developing fetus.[77]

b.6 Characterization and Measurement of Stress and Emotional Responses

Despite prolific epidemiological research on stress and birth outcomes, studies of the impact of stress on birth outcomes are inconsistent in terms of how stress is conceptualized, if a conceptual model is attended to at all, and, consequently how stress is measured. Most studies of maternal prenatal stress to date have focused on major life event stress (e.g. death of a family member or friend), chronic stressors (e.g. neighborhood problems, racism/discrimination), daily hassles, catastrophic disasters (e.g. terrorist acts), perceived stress, depression and anxiety (including pregnancy-specific anxiety).   A review by Chen and colleagues (2011) of 138 studies focused on psychosocial stress and either PTB or LBW, found that the studies used 85 different instruments to measure stress.[78]   The widely varying conceptualization and measurement of stress is likely a major driver of inconsistencies in findings and effect sizes in studies associating stress with birth outcomes,[79] such as the lack of effect on risk for preterm birth found in Littleton's meta-analysis.[80] The major domains of stress and stress responses that are most commonly measured and their associated measurement concerns are discussed below.

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Major Life Event Stress

Life event inventories, in which the respondent checks off major life events that they have experienced in a given time frame, are the most common method for capturing levels of external stress exposures.[81] The premise of checklist inventories of stressful life events is the hypothesis that a person's level of experienced stress is the result of the cumulative level of change or readjustment elicited by events happening in their life.[82,83] Research in this area is based on Selye's (1956) argument that environmental events elicit biological changes—changes that, even in small amounts but close in time, can influence susceptibility to negative health (mental and physical) outcomes.[84] Initially researchers posited that any event (either positive or negative) that elicited change or readjustment produced experiences of stress that had implications for health. While positive life events may play some role in producing stress, over time checklist inventories evolved to focus, almost entirely, on negative events after substantial research demonstrated that positive events were only weakly associated with health outcomes, while negative events were much more strongly associated with health outcomes.[85]

Measurement Considerations

There are several measurement considerations when using checklist inventories of stressful life events to quantify stress exposures. First, it is important that inventories contain a list of events that are tailored to the context of the participants (in terms of their roles, contexts and cultures) and the outcome of interest.[81] Tailoring the events in the inventories improves the instrument sensitivity and relevance to the population.[81] Second, the checklist should also be as comprehensive as possible. If an event that adds to stress is not included, the estimation of the level of stress may be inaccurate.[86] Third, assessing the timing of the events is important in research on stress and birth outcomes, particularly because pregnancy is a sensitive period characterized by rapid fetal development and physiological changes that may affect sensitivity to stressors.[28,29]

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Checklist inventories are challenged by several other measurement concerns. Role occupancy can affect the likelihood of event exposure and is particularly relevant in studies of pregnant women.[81] For example, parents with more children are more at risk for experiencing life events related to child care. As such, parents reporting more social roles will experience more stress by virtue of their increased role occupancy.[81] The problem with this is that people with more social roles may be more likely to assume those roles because they have more social competence. Thus, inventories of stressful life events would be confounded with social competence. While we expect the number of experiences of stressful life events to be associated with *more* adverse birth outcomes (one possible health outcome), social competence would (theoretically at least) be related to fewer adverse birth outcomes, and thus the estimate of the effect of stressful life events on adverse birth outcomes would be muted.[72] Studies should adjust for role occupancy to estimate a more accurate effect of stress on the health outcome of interest.[81]

In addition, there is concern that checklist inventories do not accurately ascertain the amount of stress produced by an external stressor. For example, it is probable that certain events (e.g. death of a family member) may produce more stress than others (e.g. having an argument with a family member). Some researchers argue for subjective weighting of events; however applying subjective weights may result in confounding of the stress exposure with coping (or vulnerability to stress). A subjective weight of a stressor may be a function of the ability to resolve the stressor either emotionally or through action (i.e. coping), and thus subjective ratings confound the effects of stress mediators with stress exposures.[81] Other researchers argue for regression-based weighting, in which the events are weighted in the total index by their effects on the outcome, with a responding criticism that this tactic is not theoretically driven and the weights are not generalizable across studies.[81] Turner and Wheaton argue that unweighted indices are as useful as weighted indices in predicting health outcomes citing evidence

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that effect sizes are similar, and suggest separately assessing the external stressor and the stress

mediators (e.g. coping mechanisms).[81]

Perceived Stress

Measures of stress appraisals and perceptions ascertain the individual's perception and

evaluation of potential harm posed by the external demand and their ability to cope with the demand.[71]

Constructs typically measured in research on birth outcomes include perceived stress and the

psychological impact of stressors.[78]   The most common scale measuring general perceived stress is

Cohen's Perceived Stress Scale.[78,87] The Perceived Stress Scale includes ten items that assess the degree

to which the respondent feels certain situations are stressful (e.g. how often do you feel nervous or

stressed, how often do you feel you are unable to control important things in your life).[88]

An issue when assessing the influence of stress appraisals and perceptions on health outcomes

is that the instrument is actually measuring individual traits that would be expressed regardless of a

stress stimulus.[89] In other words, stress appraisals and perceptions may be highly tied to personality

traits that make people more or less reactive to stressors (e.g. self-efficacy or optimism). As such, when

we measure perceived stress, we may actually be measuring other personality variables. Because it is

often impossible (or too late) to intervene on personality characteristics, stress appraisals and

perceptions may be more amenable to interventions and thus measures should separate appraisals and

perceptions from other personality characteristics.[90]

Another concern is that many studies among pregnant women use measures of perceived stress

that have not been validated among pregnant women.[78] There are two reasons this is problematic. First,

pregnant women are exposed to different and additional types of stressors than non-pregnant women

(e.g. travel to many appointments, concern over body appearance, learning of a problematic

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amniocentesis result). The appraisal and perception of pregnancy-specific stressors may be different

than women's appraisal and perception of general life stressors, but both can impact health and well-

being. Second, women's psychological and physiological responses to stress change during

pregnancy,[28,29] and therefore, they may perceive or appraise stressors differently as pregnancy

progresses. Thus, the validity of commonly used scales of perceived stress (e.g. the Perceived Stress

Scale) may be challenged when used among pregnant women.

Depression and Anxiety

Depression and anxiety are affective responses, or more generally described as moods, which

result from subjective experiences (versus moods that are more stable and more reflective of

personality traits). In Cohen, Kessler and Gordon's (2004) heuristic model of the pathways through

which stress affects health outcomes, affective response results from negative appraisals or perceptions

of stress, which subsequently directly affect both behavioral and physiologic responses, and risk for

physical and mental disease.[89] Affective states can also be viewed as buffers or enhancers of stress—

they can affect the perception and appraisal of stress and people with greater affective responses may

be the most vulnerable to negative health outcomes. The most commonly studied affective states in

research on stress and birth outcomes are depression and anxiety, which are composed of affective and

non-affective (e.g. feeling tired) components.[78] Among studies of birth outcomes, the Center for

Epidemiological Studies Depression Scale (CES-D)[91] is the most common measure of depression and the

State-Trait Anxiety Inventory (STAI)[92] is the most common measure of anxiety employed in this research.

<u>Measurement Considerations</u>

Measures of affective response and birth outcomes have almost exclusively focused on the constructs of anxiety and depression, despite affect being composed of a wide range of dimensions, such as sadness, happiness, and calmness.[89] As it stands, there is inconsistent evidence linking psychological constructs (such as depression and anxiety) with birth outcomes,[78] and even less evidence that these constructs mediate or moderate the effect of external stressors on birth outcomes. It is also possible, though not well studied, that certain affective responses are associated with subsequent behavioral and physiological changes that would affect health outcomes.[89] The lack of precision in the measurement of affective responses may contribute to these inconsistent findings.

The severity of affective responses may also affect physiological and behavioral changes, although there has been little attention to the severity of anxiety and depressive symptoms that may be linked to physiological mediators and birth outcomes. While there is a plethora of research on symptoms of anxiety and birth outcomes, there has been very little research on pathological levels of anxiety.[93] Further, anxiety measures developed specifically for use among pregnant women have little theoretical basis and no tests of convergent validity, which is important given the well-documented physiological and psychological changes women experience during pregnancy.[28,29,93]

c. Expectant Adolescents and Young Adults: A Vulnerable Population

While stress is a fact of life that cuts across all populations, stress may have a more substantial effect on certain vulnerable populations. Adolescents and young adults are one such population who may be especially susceptible to the ill effects of stress for several reasons. First, adolescents and young adults are still developing and may lack effective coping skills and resources.[94] Second, pregnancy itself can be a stressor for any expectant parent,[47] but the transition to parenthood may be exceptionally stressful for adolescents because they are concurrently confronting the challenges of parenthood and adolescent development.[95] Pregnancy can also give rise to or exacerbate other stressors that may be more common among adolescents and young adults compared to older expectant parents (e.g. financial concerns for supporting a new baby, relationship problems).[96] Third, during adolescence and young adulthood, social relationships outside of the family, including romantic relationships, become increasingly important.[97] An adolescent's romantic partner plays an important role in the attachment, support, and caregiving behavioral systems.[98]   Most expectant adolescents and young adults are involved with the baby's father during pregnancy;[65] however they are still learning to interact with their partner and developing their relationship skills[98] and therefore negotiating this relationship may be a significant source of stress for this population compared to older adults.

There is very little research exploring experiences of young expectant fathers, even though a partner's pregnancy is also a major life transition for expectant fathers. A young man's experiences during his partner's pregnancy may influence his own health and behavior, as well as his pregnant partners' health and behavior, carrying implications for the health and development of their baby. Despite this, the paternal experience during pregnancy, particularly among adolescent and young adult fathers, has largely been ignored in the literature. As described previously in this chapter, when the

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father's experience is acknowledged, it is usually reported by the expectant mother, introducing potential measurement error.

d. Romantic Relationship Quality and Birth Outcomes

d.1 The Influence of Relationship Quality on Birth Outcomes

Like stress, relationship quality has been associated with a variety of health outcomes, including cardiovascular disease,[99] inflammation[100] and impaired immune function.[100] It follows that relationship quality may affect reproductive health, including birth outcomes. Pregnancy is a sensitive period characterized by many psychological and physiological changes for the mother, and rapid development of the fetus. Relationship dynamics that buffer, cause or exacerbate stress may have an effect on both maternal and child health.

While there is a large body of research demonstrating the influence of relationships on general health,[58] there is little research examining the link between relationship quality and birth outcomes. Studies have focused on relationship characteristics that are easier to measure, such as marital status. Many studies have shown that married women tend to have better birth outcomes than unmarried women;[101] however, beyond married couples tending to have a higher socioeconomic status, we know little about *how* being married contributes to better birth outcomes.

Two aspects of relationship quality that may be important are support and conflict. Paternal support and involvement during pregnancy, measured by maternal report or other crude measures, has been shown to be associated with greater infant birth weight[68,102,103] and longer gestation.[68,71] Increased father support and involvement may reduce maternal stress[27,75] and influence pregnant women's health behaviors (e.g. smoking, attending prenatal care appointments),[43,46,68] ultimately influencing birth

outcomes. Measures of paternal involvement were consistently related to lower odds of LBW, the infant being small for gestational age (SGA), and more positive maternal prenatal health behaviors in a recent review of seven studies.[68] These studies measured paternal support via crude proxies for involvement, such as inclusion of father's name on birth certificate[104] and whether the father contributes financially during pregnancy.[102]

Conflict is a second dimension of parental relationship quality that could potentially affect birth outcomes through their effects on maternal stress. While social support may buffer the effects of stress on birth outcomes, conflict may cause psychological distress leading to negative health behaviors and/or physiological changes that increase risk for poor birth outcomes.[62] Little research, however, has explored if and how relationship conflict during pregnancy affects birth outcomes.

d.2 Measurement of relationship quality

Most studies of relationships and birth outcomes have used crude measures of relationship characteristics as proxies for relationship quality, including marital status, cohabiting status, father's name on birth certificate, father's presence at the child's birth, etc. These characteristics, however, tell us little about the actual quality of a couple's relationship. Relationship quality is more generally defined as the subjective, global evaluation of a relationship.[105] Measures of relationship quality were developed from research on married couples, but they have since been applied to romantic couples in general. Spanier's Dyadic Adjustment Scale (DAS) is one such measure, which asks respondents to evaluate multiple components of their relationship, which make up four constructs: consensus, satisfaction, cohesion, and affectional expression.[106]

Most often, scores on relationship satisfaction measures, including the DAS, are treated as a unidimensional construct, such that lower scores indicate less relationship quality or satisfaction (note

these terms are used interchangeably in the literature) and higher scores indicate more relationship satisfaction.[105] Fincham and Rogge (2010) argue that relationship quality may be more accurately measured by two distinct dimensions: positive and negative relationship qualities.[105] These feelings about a relationship may be experienced independently and each dimension has its own information to contribute to the understanding of a relationship. In parallel, different components of relationship quality may affect health and birth outcomes through different pathways. Social support may affect health by buffering the effects of stress, while conflict may affect health by causing psychological distress, which could lead to negative health behaviors or physiological processes that increase disease risk.[62] Thus assessing both positive and negative perceptions of a relationship may give us more information about how relationships affect health. It is therefore important to measure both positive or supportive aspects of a relationship, such as their partner's encouragement and willingness to compromise, as well as negative or conflicted aspects, such as disagreements about finances, spending time together and sexual relations.

d.3 Paternal reports of relationship quality and their influence on birth outcomes

No studies have examined whether *paternal* reports of relationship quality are associated with birth outcomes. This lack of investigation ignores the possibility that paternal well-being during pregnancy matters to the health of the baby's mother and their child. When measured, relationship characteristics and paternal support are almost always reported in research studies solely by the mother. This approach is problematic for several reasons. First, asking mothers to report their partner's contributions or feelings may introduce measurement error as these are secondhand reports. Maternal reports of her partner's feelings are likely highly influenced by her own experiences and psychological state, and therefore may differ greatly from her partner's true feelings and behaviors. Second, we are

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unable to assess whether there is an interactive effect of maternal and paternal reports of relationship quality on birth outcomes—for example, is having both parents report high levels of support from their partner much better than when only the mother reports high levels of support from her partner?

Finally, qualitative research has described how married couples perceive stress in relationships differently than unmarried couples. In one study by Waller,[107] when discussing tensions in their relationships, married couples perceived that conflicts were surmountable, while unmarried couples felt like the conflicts were risks to the stability of their relationship.[107] Couple disagreements or conflict may lead to more stress among unmarried couples than among married couples, and thus the same conflicts may have a different effect on birth outcomes based on the couple's marital status.

e. Approach and Methodological Considerations

Whether stress influences birth outcomes and whether parental relationships influence child outcomes, are interpersonal research questions. As such, these questions require analytical methods that extend beyond measuring individual effects. Observations about one individual also tell us something about other individuals within the social network.[108] For example, we can imagine that an expectant mother's stress is not only driven by her own experiences and characteristics, but also by the experiences and characteristics of individuals that she interacts with, including the father of her baby. Nearly all published research examining the effects of stress on birth outcomes uses reports from the expectant mother alone. A few studies examine the role of paternal support, but either use reports of this support from the mother or use crude measures of paternal support, such as the father's name being on the baby's birth certificate.[68]

Observations of expectant mothers and fathers within a couple (i.e. dyad) are linked and we cannot treat them as independent observations in analyses. This non-independence, or the inherent link

between measures in interpersonal research, is the core of dyadic analysis.[108] Non-independence within dyadic data can come from multiple sources. There may be mutual influence, where each individual's outcomes affect one another. There may be a partner effect, where a characteristic or behavior of one individual affects their partner's outcomes. The partners may have a common fate, where both individuals experience the same exposures. Finally, there may be a compositional effect, where the two members of a dyad may have been similar before they paired together (e.g. people tend to have relationships with people who are similar to themselves).[108] Due to the non-independence of dyadic data, the dyad should be the unit of analysis, versus the individual.[108]

Methods such as Generalized Estimating Equations, Multilevel Modeling and Structural Equation Modeling, all used within this dissertation research, can account for this non-independence of data and can be tailored specifically to dyadic data, which has particular specifications due to the low number (two, to be exact) of units within each group.[109] GEE produces population average estimates of an effect of a predictor on the outcomes and accounts for clustering of data within couples.[72] MLM is the most flexible strategy for analyzing dyadic data because it provides direct estimates of actor (effects of someone's report on own outcomes) and partner effect (effect of someone's report on a partner's outcomes) and is able to specify model constraints.[126] SEM simultaneously assesses direct, indirect and total effects of a system of variables on an outcome. SEM can also be tailored to account for clustering of data within couples.[73] This dissertation research employs each of these techniques to account for the dyadic nature of the couple data.

f. Innovation

There are several gaps in the literature that this dissertation seeks to fill. First, this research takes into account paternal effects on birth outcomes among two populations: a national sample of married and unmarried couples and a convenience sample of adolescents and young adults. Second, while epidemiological evidence shows that married women tend to have better birth outcomes, we know little about whether more detailed facets of a parental relationship, such as conflict and support, affect birth outcomes, from a stress pathway approach. Beyond relationship characteristics, very few studies have assessed direct paternal report of their perception of their relationship and whether those reports are associated with birth outcomes. Also, no studies have looked at whether the effect of parental reports of relationship quality on birth outcome differs by marital status. Third, many studies have shown that maternal experiences of stress during pregnancy are associated with negative birth outcomes; however, a woman's relationship with the baby's father likely plays a large role in this stress process. No studies have assessed how paternal stress may impact birth outcomes through potential effects on maternal factors. Fourth, no studies have explored whether experiences of stress can crossover and affect a romantic partner's health behaviors among adolescents and young adults who are expecting a baby.

g. Dissertation Research Overview

This dissertation research aims to assess the association of several dimensions of maternal and paternal stress with PTB and LBW, and the psychosocial pathways through which stress affects these outcomes. From a stress and coping framework, it also aims to assess how relationship quality is associated with PTB and LBW. Building on the conceptual frameworks posed by Dunkel-Schetter and Lobel (2012) and Misra and colleagues (2010), I pose the following conceptual framework for this dissertation research (Figure I-3).[43,67]
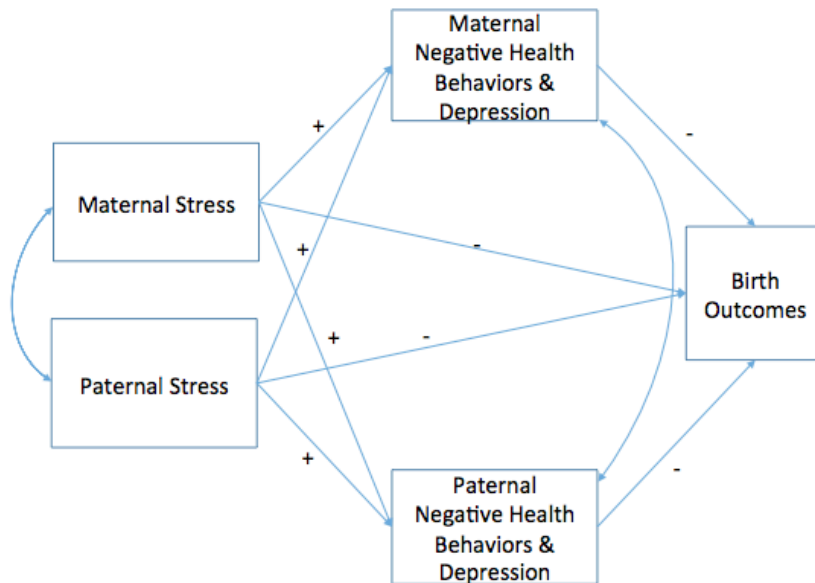
Figure I-3. Proposed conceptual model for the dissertation research assessing the effects of parental stress on birth outcomes and the behavioral and psychological pathways.

This is the first research to assess the effect of direct report of paternal experiences of stress and relationship quality on birth outcomes. It is also the first research of its kind to use dyadic data analysis methods to parcel out the independent and interactive effect of each parent among couples— particularly among young couples who may be susceptible to stress and its effects on birth and child outcomes.

The specific aims and hypotheses of this research are:

Aim 1: Assess the association of maternal and paternal reports of relationship quality with the gestational age at birth and birth weight of their baby among families in the Fragile Families and Child Wellbeing study.

> *Hypothesis 1.1*: Relationship quality factors, such as conflict and partner support, will predict birth weight and gestational age. More conflict and less support will be associated with lower gestational age and birth weight.

> *Hypothesis 1.2*: The association of relationship quality with infant birth weight and gestational age at birth will be moderated by marital and cohabiting status. Factors such as relationship conflict and support will have a stronger association with gestational age and birth weight among unmarried couples compared to married couples.

Aim 2: Investigate the association between maternal and paternal stress during pregnancy with the gestational age at birth and birth weight of their baby among a sample of young couples in southern Connecticut.

> *Hypothesis 2.1:* Greater maternal and paternal self-reported stressors during pregnancy will be associated with lower infant birth weight and gestational age at birth.

> *Hypothesis 2.2*: The association between both maternal and paternal self-reported stressors and infant gestational age at birth and birth weight will be mediated by maternal depressive symptoms.

> *Hypothesis 2.3*: Maternal stress will interact with paternal stress, such that the influence of paternal stress on gestational age at birth and birth weight depends on maternal stress levels.

Aim 3: Investigate the association between maternal and paternal self-reported stress during pregnancy and their own and their partner's poor health behaviors among a sample of young couples in southern Connecticut.

> *Hypothesis 3.1*: Greater maternal and paternal stress during pregnancy will be associated with greater poor health behaviors during pregnancy.

> *Hypothesis 3.2*: Greater *partner's* stress during pregnancy will be associated with greater poor health behaviors.

Chapter II. **Parental Reports of Relationship Quality and the Association with Birth Outcomes among Infants in the Fragile Families and Child Wellbeing Study**

a. Introduction

Preterm birth (PTB; <37 weeks gestation) and low birth weight (LBW; <2,500 grams) are among the leading causes of infant mortality in the United States (U.S.).[110] Furthermore, infants born preterm and/or with a low birth weight are at increased risk for behavioral and emotional problems during childhood, and chronic health conditions into adulthood, such as asthma, coronary artery disease and type II diabetes.[111,112] In the U.S., 11.4% of infants are born preterm and 8.0% are born with a low birth weight.[39] Beyond the implications for the child's health and development, the costs to the U.S. healthcare system associated with these birth outcomes are staggering. Medical care costs due to PTB alone exceeded $16.8 billion in the U.S. in 2005, a figure that does not include long-term productivity and educational costs to individuals and society as a whole.[113]

Every Healthy People initiative since the program's inception in the 1970s has included the goal of reducing the rates of LBW by improving the population rates of traditional risk factors, such as smoking during pregnancy and access to and use of prenatal care.[4–7] Over the last few decades there have been substantial improvements in the population rates of these traditional risk factors; however, the rates of PTB and LBW continue to remain high. For example, between 1990 and 2002, the rates of preterm birth and LBW in the U.S. each increased by about 15%,[21] while the rates of maternal smoking during pregnancy declined 38% during the same time period.[22] This evidence suggests that there may be other factors, beyond traditional risk factors, that contribute to the risk for PTB and LBW.

Researchers have identified several psychosocial factors that have been linked to the risk for preterm birth and low birth weight, including level of social support.[28,69,70] Lack of social support during pregnancy has been related to stress and anxiety[70,114] and evidence shows that maternal stress during pregnancy is consistently predictive of negative birth outcomes, including PTB[27,28,31–33] and LBW.[27,31,34,35] For example, Feldman and colleagues (2000) demonstrated among a sample of 247 low obstetric risk women of mostly European or Hispanic ethnicity in a structural equation modeling analysis, that a latent

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social support factor measured at 28-30 weeks gestation, predicted higher infant birth weight (in grams) adjusted for gestational age, marital status, education, ethnicity and obstetrical risk (standardized adjusted B=0.15; P <0.05).[69]

Romantic relationships are a substantial source of social support as well as stress,[62] and have been shown to influence many health outcomes, including cardiovascular disease,[99] inflammation[100] and immune function.[100] While an increasing number of mothers are not married when their child is born, over 80% of unmarried women are in a relationship with the baby's father during pregnancy.[115] Thus, a woman's male partner—married or not—is usually an important social relationship during pregnancy and he likely has a substantial influence on the health and wellbeing of an expectant mother during this time.

Research has shown that paternal support and involvement during pregnancy is associated with greater infant birth weight[68,102,103] and longer gestation.[68,71] Increased father support and involvement may influence birth outcomes by reducing maternal stress[27,75] and affecting pregnant women's health behaviors (e.g. smoking, attending prenatal care).[43,46,68] A recent review of seven studies found that measures of paternal involvement were consistently related to lower odds of LBW, the infant being small for gestational age (SGA) and more positive maternal prenatal health behaviors.[68] These studies measured paternal support and involvement in different ways, generally using crude proxies for involvement such as inclusion of father's name on birth certificate[104] and whether the father contributes financially during pregnancy.[102]

Paternal support is only part of how relationships can affect birth outcomes. Other dimensions of parental relationship quality, such as conflict, have the capacity to influence birth outcomes through their effects on maternal stress. Conflict may cause psychological distress leading to negative health behaviors and/or physiological changes that increase disease risk, while social support may buffer the effects of stress.[62] Little research, however, has explored if and how different dimensions of parental

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relationship quality during pregnancy affect birth outcomes. As described above, studies have focused on relationship characteristics that are easier to measure, such as marital status and whether the father's name was on the birth certificate. We know little about the mechanism by which being married or having the baby's father's name on the birth certificate (beyond their associations with socioeconomic status) leads to better birth outcomes. Relationship quality is a multidimensional construct that includes dimensions such as support and conflict.[116,117] Sources of relationship support may include a partner's encouragement and willingness to compromise, while conflict may include disagreements about finances, spending time together and sexual relations. These dimensions may have unique associations with birth outcomes.

Furthermore, measures of relationship characteristics and paternal support are almost always reported in research studies solely by the mother. This approach is problematic. Asking mothers to report their partner's contributions or feelings may introduce measurement error as these are secondhand reports. We are also unable to assess whether there is an interactive effect of maternal and paternal reports of relationship quality on birth outcomes—for example, is having both parents report high levels of support from their partner much better than when only the mother reports high levels of support from her partner?

In addition, we cannot assume that each facet of relationship quality affects birth outcomes the same way among couples in different types of relationships. Qualitative research has described how married couples perceive stress in relationships differently than unmarried couples. In one study by Waller,[107] when discussing tensions in their relationships, married couples perceived that conflicts were surmountable, while unmarried couples felt like the conflicts were risks to the stability of their relationship.[107] Couple disagreements or conflict may lead to more stress among unmarried couples than among married couples, and thus the same conflicts may have a different effect on birth outcomes based on the couple's marital status.

This study uses data from both maternal and paternal reports among married and unmarried couples in the Fragile Families and Child Well-Being study to, first, explore whether multiple dimensions of parental relationship quality during pregnancy are associated with their baby's birth weight and gestational age at birth. I hypothesize that both maternal and paternal reports of fewer couple activities, more conflict, less partner support and less relationship satisfaction will be associated with lower birth weight and earlier gestational age at birth.

Second, this study aims to look at the interactive effect of maternal and paternal reports of relationship quality on these birth outcomes. I hypothesize that when both parents report high levels of partner support, relationship satisfaction and couple activities there will be greater positive association with birth weight and gestational age than when only the mother reports high levels of these dimensions. I also hypothesize that when both parents report high levels of couple conflict there will be a more negative association with birth weight and gestational age than when only the mother reports high levels of couple conflict.[a]

Third, this study aims to assess whether the association of parental relationship quality with birth outcomes differs among married and unmarried couples. I hypothesize that both maternal and paternal reports of couple conflict will have a greater negative association with birth weight among unmarried couples than among married couples.

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[a]An alternative hypothesis could be that the difference between the parents' perception of the relationship that influences maternal stress and, subsequently, birth outcomes. This hypothesis would assume that when the father has a positive perception of the relationship and the mother does not has an equal effect on birth outcomes as when the mother has a positive perception of the relationship and the father does not. This dissertation focuses on the interaction between the maternal and paternal reports of relationship quality based on the perspective that both parents' indication of a poor relationship probably indicated the most troubled relationships with the most stress, and thus these couples will have the worst birth outcomes. This dissertation also takes the perspective that there may be differential effects on birth outcomes depending on which parent reports a negative perception their relationship.

b. Methods

b.1 Data Source

Overview and Sampling

Data for the analyses come from the Fragile Families and Child Well-Being Study (hereon referred to as Fragile Families).[118] IRB approval to use the de-identified Fragile Families survey and medical record data was obtained from the CUNY Graduate Center Human Research Protections Program. The Fragile Families and Child Well-Being Study is an ongoing longitudinal study following a national sample of new parents and their children born between the years 1998 and 2000. The study used a stratified random sample of cities with 200,000 or more people, with hospitals sampled within the cities and births sampled within the hospitals. The cities were stratified according to a scoring system that accounted for variability in the policy environments and labor market conditions within the cities. In several cities, births were sampled from all hospitals; in a few cities, hospitals were excluded for cost and efficiency reasons if the hospital had few births. In New York and Chicago, hospitals with over 1,000 non-marital births per year were randomly selected. Random samples of births were taken within each sampled hospital based on quotas that matched the percent of non-marital births in that city. Please see Reichman et al. (2001) for further details on the sampling strategy.[118]

Participants

Mothers were eligible if they were 18 years or older (in one-third of the hospitals, though, this restriction did not apply and some women under 18 were interviewed), spoke English or Spanish, were not too ill to participate, reported that the father of their new baby was living, were not planning adoption for the baby and the baby did not die before the interview could take place.

The analyses for this aim were based on the national sample of women having a singleton birth and the fathers of the index baby. Couples were included in the analysis if they were in a relationship

(reported that they were married, cohabiting or visiting), both the father and mother completed the survey and at least one outcome birth weight and/or gestational age data was available from the medical record abstraction (N=2,622 for birth weight and 2,637 for gestational age). Please see Figure II-1 below for the Data Selection Flow Chart. The data are representative of singleton births occurring in large (>200,000 people) U.S. cities.[118]
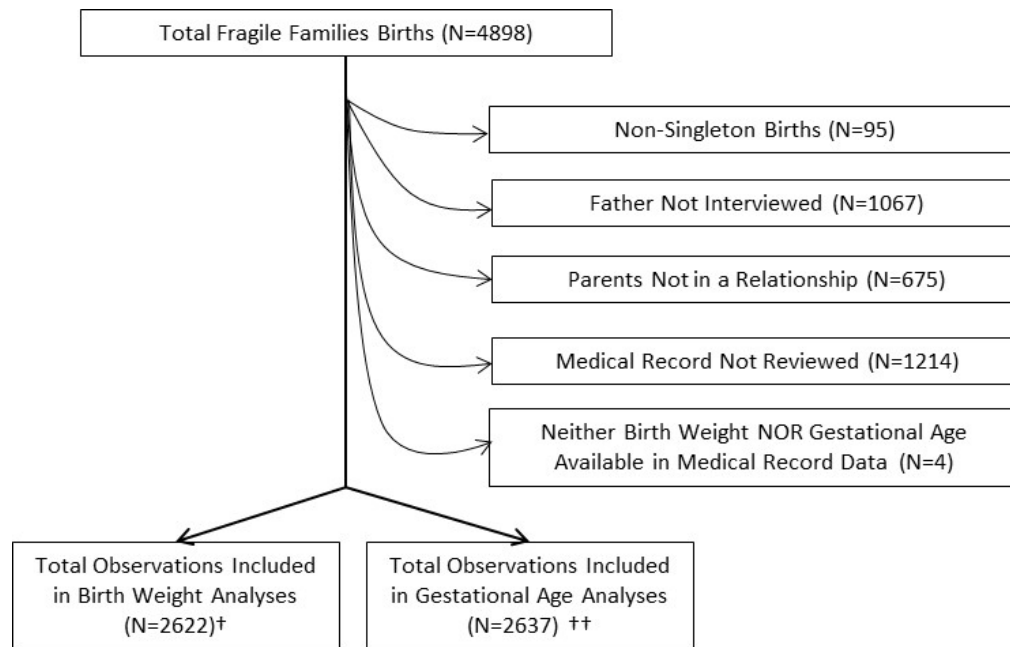
Figure II-1. Data Selection Flow Chart
† 2 of these cases did not have gestational age available †† 17 of these cases did not have birth weight available

Procedures

Parents completed baseline interviews in 75 hospitals or by phone in 20 cities across the U.S. generally within a few days of their child's birth. Mothers and 77% of fathers were interviewed within 7 days of the birth of their baby during the baseline wave of the study between the years of 1998 and 2000. Mothers were interviewed between 0 and 112 days after the birth, with 99% of the interviews taking place within seven days of the birth. Fathers were interviewed between 0 and 381 days of the birth, with 77% of the interviews taking place within seven days of the birth.[119]   Parents were asked by

trained interviewers about their health, relationships, employment, finances, and environmental factors.[118]

Trained research staff abstracted birth outcome data from birth hospitalization records for mothers and the focal children. These data were available for 3,684 births. Data for the remaining 1214 births was not available because either 1) the hospital did not grant access to this data or there were too few cases to make it financially feasible (n=461, 38%), 2) the mother refused consent (n=401, 33%) or 3) the records could not be located in the hospital (n=352, 29%).[120] All procedures were approved by the Columbia University and the Princeton University Institutional Review Boards (IRBs), and by IRBs at the participating study hospitals.

b.2 Measures

Please see Appendix II-1 and Appendix II-2 for detailed item descriptions, and estimates on the validity and reliability of the measures used in the analyses for this chapter.

Predictors

All exposure variables were measured at the baseline survey, which occurred, in most cases, within a few days after the baby's birth. Four parent-reported summary measures of relationship quality were included in this analysis: 1) *positive couple activities, 2) couple conflict*, 3) *partner support* and 4) *relationship satisfaction*. Table II-1 shows a detailed description of the relationship quality predictor variables. Reports of positive couple activities and conflict referred to experiences over the previous month. Reports of partner support and relationship satisfaction referenced the current moment in time.

Additionally, two other indicators of relationship quality were included. *The baby's father's presence at the birth* was assessed by asking the baby's father whether he was present at the birth (Yes/No). *Relationship duration* was also assessed by asking women how many years and/or months they knew the baby's father before this pregnancy began.

Table II-1. Descriptive Information about Relationship Quality Predictor Variables

Relationship Quality Predictor	Measure	Description	Response Scale	Scoring[a,b,c]
Positive Couple Activities	Original to Fragile Families	4 items asked whether they had done positive activities with baby's father/mother in the **last month** (e.g. visited with friends, helped each other solve a problem)	1=Yes 0=No	-Responses summed to form an index -Higher scores correspond to more positive activities (range: 0-4) (α=0.64 women (w), 0.60 men (m))
Couple Conflict	Adapted from National Survey of Family Health[121]	6 items assessed frequency of disagreements about specific topics in the **last month** (e.g. money, sex, being faithful)	1= never 2= sometimes 3= often	-Responses summed to form a continuous scale -Higher scores correspond to more disagreement/more conflict (range: 6-18) (α=0.65 w, 0.64 m)
Partner Support	Adapted from Multidimensional Support Scale (MDSS)[122,123] and Susan Loyd's Effects of Violence on Work and Family project.	4 items assessed frequency of supportive and destructive behavior toward respondent by the baby's father/mother (e.g., s/he is fair and willing to compromise, s/he insults or criticizes you or your ideas)	1= often 2= sometimes 3= never	-Responses summed to form a continuous scale -Supportive behaviors were reverse scored. -Higher scores correspond to more partner support (range: 4-12) (α=0.60w, 0.59 m)
Relationship Satisfaction	Original to Fragile Families	6 items ask how life might be different if they were married to the baby's father/mother (for unmarried) or not married to the baby's father/mother (for married) (e.g. financial security, happiness)	4-point scale ranging from 5=much worse to 1=much better	-Responses summed to form a continuous scale -Responses from unmarried respondents were reverse scored. -Higher scores correspond to more partner/relationship satisfaction (range: 6-30) (α=0.72 w,0 .67m)
Baby's Father present at birth	--	Asked baby's father whether he was present at the birth	1=Yes 0=No	Dichotomous
Relationship Duration	--	Asked mothers years and/or months they knew the baby's father before the pregnancy	Months	Continuous (range: 0-432)

[a]Chonbach's Alpha (α) were conducted for all variables except a Kuder Richardson (KR-20) test of internal consistency was conducted for positive couple activities.
[b]All internal consistency estimates are from this dataset.
[c]"w" stands for estimates among women and "m" stands for estimates among men

Outcomes

The baby's *gestational age at delivery* and *birth weight* were ascertained from the mother's medical record at the birth hospitalization. Gestational age was recorded in weeks and birth weight was recorded in grams.

Covariates

Several confounders were accounted for during model building and are described in detail in Appendix II-1. Demographic confounders included maternal household income,[b] both maternal and paternal age, education and race/ethnicity, and maternal parity, marital status and whether she paid with Medicaid or was otherwise uninsured at the time of delivery.

Other maternal clinical/health confounders included a history of mental health problems before pregnancy, prenatal care, gestational diabetes, pre-eclampsia or eclampsia, obesity during pregnancy, child gender and HIV/STI positive during pregnancy. Due to the low prevalence of HIV in the population, HIV and STIs were combined into one variable to strengthen the model and avoid large confidence limits. These measures were abstracted from the mother's medical record.

Maternal use of drugs, alcohol and cigarettes during pregnancy (all yes/no) were also accounted for. These measures were abstracted from the mother's medical record.

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[b]The question asked both parents, "Thinking about your income and the income of everyone else who lives with you, what was your total household income before taxes in the past 12 months?" Data was collected in categorical form from the respondent and then they were given the mean value for that category. However, about 25% of data was missing. For married and cohabiting couples, the mother's report was used if available, and the father's report was used otherwise. If household income was missing for both parents, the income was imputed using Stata's regression-based impute command. Because this variable is therefore a combination of maternal and paternal reports, only the maternal variable was included in statistical models. Please see "Introduction to the Fragile Families Public Use Data" (2008)[119] for details on the construction of this variable.

Since many of these covariates could also be considered on the pathway between relationship quality and birth outcomes, analyses accounted for the variables in blocks, sequentially. Please see *regression model building* in the Statistical Analysis section below.

Effect Measure Modifier

Marital status (yes/no) was treated as an effect measure modifier with the hypothesis that relationship quality would have a different effect on birth outcomes among married and unmarried couples.

Clustering and Weighting Variables

Due to the sampling procedures described above, descriptive statistics were run using city weights, making the estimates representative of births in the mother's city in the year of the interview.[124] Reliability estimates, correlations and t-tests were not run using any weighting or cluster variables. All regression analyses accounted for city and hospital variables by including these terms in the cluster statement within the SAS procsurvey command instead of using the city weights. Because mothers' and fathers' responses were included within the same model, a variable identifying the couple (ffchid) was also included in the cluster statement. Because unmarried births were oversampled, all analytical models controlled for marital status (coded 0/1) within the regression equation.

b.3 Statistical Analysis

Descriptive Statistics

Descriptive statistics were produced using SAS 9.3 proc freq and proc means commands with city weights applied. All remaining analyses used SAS 9.3 procsurvey commands and accounted for clustering by couple, and marital status, city and hospital due to the sampling scheme. Because the sampling weights were not a function of the outcomes, unweighted regression estimates that controlled for the clustering variables were preferred because they are less biased, consistent and have smaller standard errors.[125]   Procsurvey commands create robust standard errors and therefore the estimates are robust against non-normality.

Reliability estimates were calculated for the relationship quality predictor variables separately among mothers and fathers, and were sufficient for research purposes (Table II-1).

The amount of correlation between the mother's and father's report of the relationship quality predictor variables was also assessed (Table II-2). With the exception of relationship satisfaction, there was a moderate amount of correlation between the predictor variable responses (except a low amount of correlation between reports of relationship satisfaction)[126] among mothers and fathers within couples. Correlation coefficient values corrected for attenuation (by the variable reliability estimates) were also calculated in order to evaluate how highly correlated the scales would be if they were measured without error (Table II-2, columns 3, 5 and 7). These values were calculated for the entire population of interest (columns 2,3), for married (columns 4,5) and unmarried couples (columns 6,7), and for mothers and fathers interviewed within one month of each other (columns 8,9) and not (columns 10,11).

The fact that the corrected coefficients in all cases were higher demonstrates that the correlation of mother and father reports could be even greater if the reliability of the variables were greater. Only positive couple activities reached a fairly high level of correlation (.72) indicating that about half of the variation in scores is shared within couples. Nevertheless, some of the variance in

scores is not shared, allowing the assessment of the contribution of each partner's reports of the relationship quality predictor variables. Therefore, all regression models that include both mother's and father's reports account for clustering by couple by including the couple identifier within the cluster statement of the SAS procsurvey command.

To compare the maternal and paternal relationship quality predictor variables, I also ran paired t-tests using the proc surveymeans command as described in Scerbo and Lajiness (2015)[127] to employ the city weights and control for marital status.

I also ran bivariate linear regression models between each predictor variable and each outcome separately using SAS proc surveyreg and employing city weights and controlling for marital status.

Table II-2. Pearson Correlations and Correlations Corrected for Attenuation between maternal and paternal reports of relationship quality among the subpopulation of interest.

	Total		Married		Unmarried		Interviewed within 1 month		Not Interviewed within 1 month	
	r	Corrected r	r	Corrected r	r	Corrected r	r	Corrected r	r	Corrected r
Positive Couple Activities	0.43	0.70	0.40	0.64	0.43	0.69	0.45	0.72	0.34	0.54
Couple Disagreements	0.35	0.54	0.43	0.67	0.31	0.48	0.39	0.60	0.17	0.27
Partner Support Behaviors	0.26	0.44	0.27	0.46	0.25	0.42	0.27	0.46	0.19	0.31
Relationship Satisfaction	0.26	0.37	0.14	0.20	0.10	0.15	0.12	0.17	0.02	0.03

Regression Model Building

Initially, generalized estimating equations (GEE) were employed to account for the correlated nature of the couple reports and, therefore, clustering by couple. Generalized estimating equations can help parcel out the association of each parent's report with the birth outcomes. GEE produces population average estimates of the association of the predictor on the outcomes and accounts for clustering of data within couples.[128] GEE analyses, however, are not particularly amenable to handling multiple clustering variables. Due to the sampling structure, the analyses needed to account for multiple levels of clustering, including couple, city, hospital and marital status. Therefore, the analyses were also conducted using a random effects model, while accounting for all of the clustering variables. As expected, the effect estimates were the same when employing a random effects model accounting for the clustering variables and GEE. The confidence intervals for estimates created using GEE were only slightly tighter than those of the effects model and the results were substantively the same. Therefore, I present the results from random effects models that account for all clustering variables, which are in effect, more conservative than the GEE models.

To start model building, bivariate associations were examined between each exposure variable (mother and father reports included simultaneously) and each birth outcome separately (birth weight and gestational age) while controlling for marital status.

Next, multivariate linear regression models were tested between all exposure variables and each birth outcome separately, including both mothers' and fathers' reports simultaneously within the models. Covariates were added in blocks in progressively more complex models. Model a included all maternal and paternal relationship quality predictor variables and controlled for marital status. Model b added other maternal and paternal demographic variables. Model c added maternal clinical health variables. Model d added maternal drug use during pregnancy variables.

To ensure that the time difference between the interviews did not have an unexpected effect on the estimates, model d was also run accounting for the time difference between parental interviews (within 1 month of each other vs. not). This variable was not significantly associated with either birth outcome in multivariate models, and the effect sizes and significance testing were not substantively changed with the addition of this variable. All models therefore exclude the time difference between parental interviews variable.

Exploration of the Interaction of Mother's and Father's Relationship Quality Reports

Next, I explored whether maternal and paternal reports had an interactive association with the birth outcomes. I hypothesized that the effect of a negative paternal report of relationship quality would be buffered by the effect of a positive maternal report of relationship quality. I also hypothesized that the greatest negative effect on birth outcomes would be when both parents reported a negative perception of their relationship. Models assessed the statistical interaction between maternal and paternal reports of the relationship quality variables conditioned on the same variables included in the full models (model d).

When there was a significant interaction between maternal and paternal reports on a relationship quality predictor variable ($P<.05$) I analyzed the effect of maternal report of the relationship quality variable at three levels of paternal report of the relationship quality variables. For example, I explored the estimates of the effect of maternal report of couple conflict on birth weight when the father's report was -1 SD, +1 SD and at the mean of father's report of couple conflict.

First, I plotted the association of the maternal report of a relationship quality predictor with the outcome (birth weight or gestational age) controlling for all covariates at 3 levels of the paternal reports (low: 1 SD below the mean; medium: the mean; high: 1 SD above the mean). Second, I assessed

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whether the effects of maternal report (controlling for all covariates) at the three levels of the paternal report were significant according to Aiken and West (1991).[129]

Effect Measure Modification by Marital Status

To determine whether the association between relationship quality and birth outcomes differed by marital status, I tested for 2-way interactions between marital status and relationship quality by including interaction terms (e.g. marital status*relationship quality variable for mothers and fathers) in multivariate logistic regression models using the Wald test for product term (a p-value of <0.05 indicating significant interaction). When a significant interaction (P<0.05) was present between a relationship quality predictor variable and marital status, plots were created of the association between the continuous predictor and the birth outcome by marital status. The significance levels of the simple slopes of the regression lines for married and unmarried respondents were determined.

c. Results

c.1 Descriptive Statistics

Demographics

Table II-3 describes the characteristics of the parents included in the sample for this analysis when employing the city weights. The mean birth weight was 3,328.4 grams (95% CI 3268.8, 3387.9) and the mean gestational age at birth was 38.6 weeks (95% CI 38.4, 38.9). The average age of women and men was 27.0 (95% CI 26.3, 27.6) and 29.7 (95% CI 29.1, 30.4), respectively, and 58.5% of parents were married. Women's and men's mean reported household income were just over $43,000. Over half of the participants had a high school degree/equivalent or less education. Most participants were black (30.1% women; 31.9% men) or Hispanic (32.6% women; 37.3% men). Most parents (84.7%) were interviewed within one month of each other.

Behavioral and Clinical Covariates

Cigarette use was somewhat common during pregnancy, with 13.3% of women having smoked at some point during their pregnancy. 8.0% of women had a pre-pregnancy diagnosis of a mental health problem. The vast majority of women started their prenatal care within the first three months of pregnancy (79.0%). Over half of the women received federal or other assistance to pay for the hospital costs associated with their delivery (54.2%). Nearly 12% of women had a sexually transmitted infection (STI) or HIV during their pregnancy.

Table II-3. Descriptive statistics (weighted) for subpopulation used in all analyses (singleton births, parents in a relationship, both the father and mother completed the survey and either or both birth weight and/or gestational age data was available from the medical record abstraction).[c]

Descriptive Statistics (Using city weights)	MOTHERS			FATHERS		
	Total N	Mean	95% CI		Total N	Mean	95% CI	
Birth weight (g)	2615	3328.4	3268.8	3387.9			
Gestational Age (weeks)	2630	38.6	38.4	38.9			
Positive Couple Activities	2603	3.2	3.1	3.4	2593	3.2	3.1	3.3
Couple Conflict	2597	8.1	7.9	8.3	2585	8.1	7.9	8.3
Partner Support Behaviors	2480	10.8	10.5	11.0	2470	10.8	10.7	10.9
Relationship Satisfaction	2482	20.3	19.9	20.7	2446	19.9	19.5	20.2
Relationship Duration (mo) Before Preg	2562	78.3	71.4	85.2	2586	78.2	71.4	85.1
Age	2631	27.0	26.5	27.6	2632	29.7	29.1	30.4
Household Income (in thousands)	2632	43.9	38.7	49.1	2632	43.4	39.8	46.9
Parity	2627	1.2	0.9	1.4	2615	1.1	1.0	1.3
	Total N	%	95% CI		Total N	%	95% CI	
Father Present at Birth	2627	95.7	94.8	96.6	2620	85.8	83.0	88.6
Married	2632	58.5	56.1	60.9			
Parents interviewed w/i 1 wk	2639	80.5	76.6	84.5			
Education	2629				2632		
Less than HS		29.9	25.9	33.8		32.2	28.4	36.0
HS or Equivalent		31.9	27.7	36.2		27.6	22.2	33.1
Some college or tech school		19.3	15.8	22.8		21.2	18.0	24.4
College or Grad School		18.9	15.2	22.7		19.0	14.2	23.7
Payment for Delivery: Medicaid/gov assistance/uninsured	2632	54.2	47.9	60.6			
Race/Ethnicity	2629				2632		
White		30.7	25.0	36.4		24.8	20.0	29.6
Black		30.1	26.9	33.2		31.9	27.6	36.2
Hispanic		32.6	29.1	36.1		37.3	32.6	41.9
Other		6.6	2.6	10.6		6.0	2.8	9.3
Maternal Clinical Health							
Mental Health Problems during preg	2632	8.0	5.7	10.4			
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Trimester PNC Start	2609							
Within 3 mo		79.0	74.6	83.4				
After 3 mo		18.4	15.9	20.9				
Never		2.6	0.0	6.3				
Gestational diabetes	2632	8.0	3.8	12.2				
Pre-Eclampsia/Eclampsia	2632	4.9	2.2	7.6				
Obesity	2632	8.8	5.0	12.5				
STI or HIV during Pregnancy	2632	12.0	9.2	14.8				
Baby Boy	2632	59.0	52.4	65.7				
Maternal Substance Use During Pregnancy								
Cigarettes during pregnancy	2632	13.3	10.9	15.7				
Drugs during pregnancy	2632	4.8	2.7	6.9				
Alcohol during pregnancy	2632	5.8	3.1	8.5				

Relationship Quality Predictors

On average, mothers and fathers reported engaging in three out of four *positive activities* with each other in the previous month. The most common activity reported was helping each other solve a problem (91.4% of mothers and 91.2% of fathers) and the least common activity was going to a movie (66.1% of mothers and 64.0% of fathers).

The most common topic of *couple conflict* was money, with 54.6% of mothers and 51.5% of fathers reporting sometimes or often disagreeing about money in the last month. The second most common topic of conflict was spending time together, with 44.9% of mothers and 46.2% of fathers reporting sometimes or often disagreeing about spending time together in the last month. The least common topic was conflict about drug or alcohol use, with 9.5% of mothers and 10.8% of fathers reporting sometimes or often disagreeing about drug or alcohol use in the last month.

Nineteen percent of mothers and 15.9% percent of fathers reported low *satisfaction with their relationship* (response one standard deviation below the mean or lower). Twenty percent of mothers and 21% of fathers report low *partner support* (response one standard deviation below the mean or lower).

Because one of the aims of the research is to compare effects by marital status, the characteristics of the sample among unmarried and married parents (unweighted) are presented in Table II-4 (mothers) and Table II-5 (fathers). Married couples had babies that were heavier at birth (3,365.8g vs. 3,203.1g) and had a slightly longer gestation (38.8 vs. 38.5 weeks) compared to unmarried couples. Married couples also generally reported more positive responses to the relationship quality variables and fewer clinical health risk factors.

Table II-4. Descriptive characteristics of mothers by marital status (unweighted)

Descriptive Statistics (Unweighted)	Mothers							
	Married				Unmarried			
	N	Mean	95% CI		N	Mean	95% CI	
Birth weight (g)	734	3365.8	3322.9	3408.8	1888	3203.1	3175.7	3230.5
Gestational Age (weeks)	739	38.8	38.6	38.9	1898	38.5	38.4	38.6
Positive Couple Activities	732	3.4	3.3	3.5	1878	3.0	2.9	3.0
Couple Conflict	731	7.9	7.8	8.1	1873	8.7	8.6	8.8
Partner Support Behaviors	610	11.0	10.9	11.1	1876	10.7	10.6	10.7
Relationship Satisfaction	676	20.8	20.5	21.1	1813	20.1	20.0	20.3
Relationship Duration (mo) Before Preg	713	90.2	85.6	94.7	1856	47.0	44.8	49.2
Age	739	29.2	28.8	29.6	1899	23.7	23.5	24.0
Household Income (in thousands)	739	56.4	53.4	59.4	1900	25.1	24.0	26.1
Parity	738	1.1	1.1	1.2	1896	1.2	1.1	1.2
	N	%	95% CI		N	%	95% CI	
Father Present at Birth	722	98.0	96.9	99.0	1707	90.0	88.6	91.3
Parents interviewed w/i 1 wk	644	87.1	84.7	89.6	1471	77.4	75.5	79.3
Education								
Less than HS	139	18.8	16.0	21.6	776	40.9	38.7	43.1
HS or Equivalent	151	20.4	17.5	23.3	638	33.6	31.5	35.8
Some college or tech school	201	27.2	24.0	30.4	429	22.6	20.7	24.5
College or Grad School	248	33.6	30.1	37.0	54	2.8	2.1	3.6
Payment for Delivery: Medicaid/gov assistance/uninsured	235	31.8	28.4	35.2	1431	75.3	73.4	77.3
Race/Ethnicity								
White	289	39.1	35.6	42.6	278	14.7	13.1	16.3
Black	179	24.2	21.1	27.3	993	52.3	50.1	54.6
Hispanic	216	29.2	25.9	32.5	572	30.2	28.1	32.2
Other	55	7.4	5.5	9.3	53	2.8	2.1	3.5
Maternal Clinical Health								
Mental Health Problems dur preg	64	8.7	6.6	10.7	241	12.7	11.2	14.2
Trimester PNC Start								
Within 3 mo	646	89.0	86.7	91.3	1442	76.3	74.4	78.2
After 3 mo	69	9.5	7.4	11.6	403	21.3	19.5	23.2
Never	11	1.5	0.6	2.4	45	2.4	1.7	3.1
Gestational diabetes	51	6.9	5.1	8.7	86	4.5	3.6	5.5
Pre-Eclampsia/Eclampsia	43	5.8	4.1	7.5	95	5.0	4.0	6.0
Obesity	44	6.0	4.2	7.7	186	9.8	8.5	11.1
STI or HIV during Pregnancy	55	7.4	5.5	9.3	377	19.8	18.0	21.6
Baby Boy	390	52.8	49.2	56.4	979	51.5	49.3	53.8
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Maternal Substance Use During Pregnancy							
Cigarettes during pregnancy	62	8.4	6.4	10.4	461	24.3	22.3	26.2
Drugs during pregnancy	19	2.6	1.4	3.7	213	11.2	9.8	12.6
Alcohol during pregnancy	25	3.4	2.1	4.7	147	7.7	6.5	8.9

Table II-5. Descriptive characteristics of fathers by marital status (unweighted).

Descriptive Statistics (Unweighted)	Fathers							
	Married				Unmarried			
	Total N	Mean	95% CI		Total N	Mean	95% CI	
Positive Couple Activities	733	3.4	3.3	3.4	1867	3.1	3.0	3.1
Couple Conflict	733	7.9	7.8	8.1	1859	8.7	8.6	8.8
Partner Support Behaviors	615	10.9	10.7	11.0	1862	10.6	10.6	10.7
Relationship Satisfaction	677	19.6	19.4	19.8	1776	20.4	20.2	20.5
Relationship Duration (mo) Before Preg	721	90.8	86.1	95.5	1872	47.1	44.9	49.3
Age	739	31.7	31.2	32.1	1900	26.3	26.0	26.6
Household Income (in thousands)	739	56.4	53.4	59.4	1900	28.8	27.6	29.9
Parity	733	1.2	1.1	1.3	1889	1.1	1.0	1.2
	N	%	95% CI		N	%	95% CI	
Father Present at Birth	692	93.8	92.0	95.5	1434	75.9	74.0	77.8
Education								
Less than HS	146	19.8	16.9	22.6	747	39.3	37.1	41.5
HS or Equivalent	173	23.4	20.4	26.5	743	39.1	36.9	41.3
Some college or tech school	202	27.3	24.1	30.6	358	18.8	17.1	20.6
College or Grad School	218	29.5	26.2	32.8	52	2.7	2.0	3.5
Race/Ethnicity								
White	286	38.7	35.2	42.2	218	11.5	10.0	12.9
Black	196	26.5	23.3	29.7	1034	54.4	52.2	56.7
Hispanic	208	28.1	24.9	31.4	580	30.5	28.5	32.6
Other	49	6.6	4.8	8.4	68	3.6	2.7	4.4

Table II-6 shows that within couples, mother's and father's reports of relationship quality variables did not differ significantly. Mothers reported marginally more relationship satisfaction than their male partners (P=.06).

Table II-6. Paired T Tests comparing mother's and father's reports of the relationship quality predictors within couples.

	Mean Mother	Mean Fathers	Mean Diff	t	p
Positive Couple Activities	3.24	3.22	0.02	0.28	0.79
Couple Disagreements	8.07	8.07	0.02	0.20	0.85
Partner Support Behaviors	10.77	10.78	-0.02	-0.15	0.89
Relationship Satisfaction	20.33	19.89	0.45	2.12	0.06

Table II-7 shows the correlation matrix between the relationship quality variables among mothers and fathers separately. The highest correlation between variables for both men and women was between couple conflict and partner support (r=-0.42, P<.001 mothers; r=-.03, P<.001 fathers). The higher the conflict reported, the lower the parents' report of their partner's support.

Table II-7. Pearson Correlation matrix of relationship quality variables for mothers and fathers (unweighted).

a. MOTHERS	Relationship Duration	Father at Birth	Relation-ship Sat	Partner Support	Conflict
Positive Activities	0.03	0.27***	0.05*	0.27***	-0.09***
Conflict	-0.03	-0.08***	-0.09***	-0.42***	
Partner Support	0.02	0.14***	0.14***		
Relationship Sat	0.06**	0.01			
Father at Birth	0.02				
b. FATHERS	Relationship Duration	Father at Birth	Relationship Sat	Partner Support	Conflict
Positive Activities	0.01	0.25***	.02	0.22***	-0.07***
Conflict	-0.08***	-0.09***	-0.07***	-0.31***	
Partner Support	0.02	0.11***	0.2***		
Relationship Sat	-0.06**	-.04			
Father at Birth	0.02				

* P<0.05; ** P<0.01; ***P<0.001

Table II-8 shows that among fathers, couple conflict, activities and his presence at birth were significantly associated with both birth weight and the latter two variables were associated with gestational age. Among mothers, however, none of the relationship quality predictor variables were associated with the birth outcomes. Most of the covariates were significantly correlated with both birth outcomes.

Table II-8. Bivariate linear regressions of predictor variables and covariates with birth weight in grams and gestational age in weeks conducted separately among mothers and fathers employing city weight and controlling for marital status.

	Birth weight		Gestational Age	
	Mothers	Fathers	Mothers	Fathers
Couple Activities	17.45	22.95 *	0.07	0.09 *
Couple Conflict	-9.83 †	-16.17 **	-0.02	-0.03
Partner Support	7.55	-1.19	0.03	-0.02
Relationship Satisfaction	3.19	-2.33	-0.01	0.00
Relationship Duration	0.31	0.30	0.00	0.00
Father at Birth	58.23	125.52 ***	0.13	0.61 ***
Father's Age		-1.13		-0.02 **
Mother's Age <20	-39.41		0.20 †	
20-34	48.23 †		-0.01	
35+	-48.45		-0.30 †	
HH Income (in thousands)	0.43	0.53	0.00	0.00
Education < HS	9.79	-16.68	0.02	-0.05
HS or Equiv	-69.56 **	-50.46 *	-0.03	-0.11
Some college or tech school	42.61	67.41 *	0.00	0.15
College or Grad School	55.97	46.84	0.06	0.12
Parity	-6.41	-4.31	-0.13 ***	-0.07
Interviewed within 1 week (vs. not)	74.25 *		0.21	*
Paid w/ Medicaid or Uninsured	-93.04 ***		-0.13	
Race White	65.27 *	54.49 †	0.12	0.11
Black	-185.49 ***	-182.27 ***	-0.33 ***	-0.37
Hispanic	151.29 ***	170.69 ***	0.28 **	0.34 ***
Other	2.11	-16.80	-0.02	0.05 ***
Mental Health Problems	-113.90 **		-0.40 **	
Prenatal Care Within first 3 months	70.15 *		0.25 *	
After 3 months	-32.53		-0.09	
Never	-249.53 *		-1.00 *	
Gestational Diabetes	170.88 **		-0.18	
Pre-eclampsia/Eclampsia	-297.00 ***		-1.13 ***	
Obesity	121.71 *		0.00	
HIV/STI	-128.07 ***		-0.41 **	
Child Gender	75.70 **		-0.03	
Smoking	-208.34 ***		-0.38 **	
Drugs	-211.66 ***		-0.65 ***	
Alcohol	-202.27 ***		-0.63 **	

†=P<0.1; * P<0.05; ** P<0.01; ***P<0.001;

c.2 Linear Regression with Birth Weight and Gestational Age

Relationship Quality and Birth Weight

Base models run separately for each relationship quality predictor variable, but that included both maternal and paternal reports and controlled for couple, city, hospital and marital status, showed that greater paternal report of conflict in the previous month was significantly associated with lower birth weight (B=-15.63 grams; 95% CI -26.28,-4.98)(Table II-9).

Results also showed that babies born to fathers who were present at the birth were on average 125.5 grams (95% CI 59.0, 192.0) heavier than babies born to fathers who were not present at birth. No other maternal or paternal reports of relationship quality predictor variables were significantly associated with birth weight in crude models. As a point of reference, recent studies have estimated that babies born to light smokers during pregnancy are on average 160 grams lighter at birth than babies born to non-smokers.[130] In this study, the full regression model shows that babies born to smokers were also, on average, 162.60 grams lighter than babies born to non-smokers (Table II-11).

Table II-9. Bivariate linear regression models for birth weight. Models a-f were run separately for each relationship quality predictor variable, with both mother's and father's reports within the same model.

Model N	Birth Weight	B	95% CI	
a	**Positive Couple Activities**			
N=2556	Women	8.71	-15.56	32.98
	Men	18.21	-5.64	42.06
b	**Couple Conflict**			
N-2544	Women	-4.67	-16.40	7.06
	Men	-15.63**	-26.28	-4.98
c	**Partner Support**			
N=2429	Women	7.73	-11.33	26.79
	Men	-5.24	-23.63	13.15
d	**Relationship Satisfaction**			
N=2309	Women	2.51	-5.62	10.63
	Men	-1.76	-9.59	6.06
e	**Baby's Father at Birth**			
N=2610		125.51***	59.03	191.99
f	**Relationship Duration (mo)**			
N=2553		0.31	-0.15	0.76

** $P<0.01$; ***$P<0.001$

Relationship Quality and Gestational Age

In base models with gestational age as the outcome that included both maternal and paternal reports, the only relationship quality predictor variable that was significantly associated with gestational age at birth was the baby's father's presence at the birth (Table II-10). Babies born to fathers who were present at the birth were born, on average, 0.61 weeks (4.27 days) later than babies whose father was not present at the birth (B=0.61; 95% CI 0.34, 0.88). As a point of reference, in this study, the full regression model (model d) shows that babies born to non-smokers were, on average, born nearly 1 day later than smokers (Table II-12).

Table II-10. Bivariate linear regression models for gestational age. Models a-f were run separately for each relationship quality predictor variable, with both mother's and father's reports within the same model.

Model N	Gestational Age	B	95% CI	
a	**Positive Couple Activities**			
N=2571	Women	0.04	-0.06	0.13
	Men	0.07	-0.02	0.16
b	**Couple Conflict**			
N=2558	Women	-0.01	-0.05	0.04
	Men	-0.04	-0.08	0.01
c	**Partner Support**			
N=2682	Women	0.03	-0.04	0.11
	Men	-0.04	-0.11	0.03
d	**Relationship Satisfaction**			
N=2321	Women	-0.01	-0.04	0.02
	Men	-0.01	-0.04	0.03
e	**Baby's Father at Birth**			
N=2625		0.61***	0.34	0.88
f	**Relationship Duration (mo)**			
N=2567		0.00	0.00	0.00

***P<0.001

c.3 Multivariate Linear Regression with Birth Weight and Gestational Age

Relationship Quality and Birth Weight

Multivariate models that included all of the maternal and paternal reports of the relationship quality predictor variables, and added confounders in a hierarchical fashion showed results similar to the results described above in the simpler base models (Table II-11, models a-d). In the final model (model d), which included all covariates, father's presence at the birth (B= 98.81, 95% CI 21.58, 176.04) was significantly associated with birth weight when controlling for marital status, city, hospital, couple, maternal and paternal demographics, maternal clinical health and maternal substance use during pregnancy (Table II-11, model d). The coefficient for father's presence at birth was reduced by 32.19 grams once all variables were added to the model, but remained statistically significant. This suggests that the confounders and the potential mediators (e.g. smoking) account for much, but not all of the association of the father's presence at birth with birth weight. With the addition of maternal substance use during pregnancy (models c to d), which could also be considered mediators as substance use may result from high levels of stress, the coefficient of the effect of father's presence at the birth changed by 0.20 grams, or 0.2%.

Paternal report of conflict remained marginally significantly associated with birth weight (B=-11.54; 95% CI -23.54, 0.47) in the final model accounting for maternal and paternal demographics, maternal clinical/health and maternal substance use during pregnancy. With the addition of maternal substance use during pregnancy (models c to d), the coefficient of paternal report of conflict became marginally significant, but was reduced by only 0.91 grams, or 7%. Thus, it is unlikely that maternal substance use during pregnancy was a strong mediator in this analysis.

Relationship Quality and Gestational Age

In multivariate models, paternal report of conflict (B= -0.05; 95% CI 0.11,-0.002) and father's presence at the birth (B= 0.51; 95% CI 0.19, 0.83) were significantly associated with gestational age at birth when controlling for all covariates (Table II-12, model d). The coefficient for father's report of conflict remained virtually unchanged with the addition of control variables (from -0.06 in model a to -0.05 in model d), suggesting that neither the confounders nor the potential mediators account for the association between father's report of conflict and gestational age at birth.

The coefficient for the father's presence at the birth was reduced the most with the addition of maternal and paternal demographic variables (from 0.63 in model a to 0.56 in model b) and only slightly reduced with the addition of maternal clinical health indicators and pregnancy substance use (0.51 in model d). The addition of maternal substance use during pregnancy (model c to d) did not change the coefficient of the association of the father's presence at birth with gestational age. Thus, it is unlikely that maternal substance use during pregnancy was a strong mediator in this analysis.

Table II-11. Multivariate linear regression models predicting birth weight (grams)

Outcome: Birth Weight (g)	Model a N=2068				Model b N=2063				Model c N=2063				Model d N=2063			
	B		95% CI		B		95% CI		B		95% CI		B		95% CI	
Positive Couple Activities																
Mother	10.25		-18.31	38.81	1.73		-26.69	30.14	2.68		-25.35	30.70	4.65		-23.00	32.29
Father	12.56		-15.73	40.85	-0.36		-28.76	28.04	2.35		-25.73	30.42	4.01		-23.99	32.01
Couple Conflict																
Mother	-6.16		-19.96	7.64	-3.12		-16.99	10.75	-2.59		-16.48	11.29	0.10		-13.93	14.13
Father	**-16.99**	**	**-29.18**	**-4.79**	**-13.69**	*	**-25.78**	**-1.6**	**-12.45**	*	**-24.51**	**-0.40**	**-11.54**	t	**-23.54**	**0.47**
Partner Support																
Mother	-1.87		-25.69	21.96	-5.68		-29.52	18.16	-6.52		-30.21	17.18	-6.09		-29.55	17.38
Father	-18.87	t	-40.88	3.14	-17.23		-39.27	4.82	-19.12	t	-40.73	2.49	-20.85	t	-42.30	0.61
Relationship Satisfaction																
Mother	0.55		-8.09	9.19	1.56		-6.94	10.05	1.44		-7.02	9.90	0.87		-7.48	9.22
Father	-1.23		-9.59	7.14	0.34		-7.95	8.63	0.12		-8.12	8.37	0.15		-8.05	8.36
Baby's Father at Birth	**131.00**	**	**51.75**	**210.26**	**110.74**	**	**31.97**	**189.5**	**99.01**	**	**20.94**	**177.08**	**98.81**	*	**21.58**	**176.04**
Relationship Duration (mo)	0.49	t	-0.03	1.02	0.58	*	0.05	1.12	0.47	t	-0.07	1.01	0.41		-0.13	0.94
Maternal Demographics																
Married	95.65	**	32.02	159.27	17.70		-54.00	89.4	27.66		-43.36	98.68	8.65		-62.17	79.46
Age (ref: 20-34)																
<20					-27.12		-101.36	47.12	-10.80		-85.72	64.13	-13.35		-87.35	60.64
35+					-93.26	t	-203.15	16.62	-83.86		-192.39	24.67	-73.79		-180.34	32.75
HH Income (in thousands)					-1.20		-2.83	0.42	-1.13		-2.74	0.48	-1.19		-2.79	0.42
Education (ref: less than HS)																
HS or Equivalent					-22.45		-92.73	47.83	-33.03		-103.70	37.65	-37.32		-106.97	32.32
Some college or tech school					20.52		-62.85	103.89	9.82		-73.49	93.14	-2.10		-84.31	80.11
College or Grad School					53.56		-78.98	186.1	48.14		-83.94	180.22	20.82		-109.85	151.49
Parity					15.18		-8.05	38.41	16.82		-6.10	39.74	18.85		-4.23	41.93

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	Coef	Sig	Lower	Upper	Coef	Sig	Lower	Upper	Coef	Sig	Lower	Upper
Paid w/ Medicaid or Uninsured	-92.27	**	-155.11	-29.42	-65.80	*	-128.21	-3.39	-64.69	*	-127.12	-2.26
Race/Ethnicity (ref: white)												
Black	-85.26		-222.37	51.85	-97.36		-236.43	41.72	-123.51	t	-264.36	17.34
Hispanic	29.78		-78.98	138.54	23.95		-85.68	133.58	-13.88		-123.02	95.27
Other	-83.58		-240.92	73.75	-121.93		-277.63	33.77	-149.43	t	-308.36	9.51
Paternal Demographics												
Age	-3.47		-8.81	1.87	-3.39		-8.58	1.80	-1.73		-6.92	3.47
HH Income (in thousands)	0.82		-0.78	2.43	0.79		-0.77	2.36	0.74		-0.83	2.31
Education (ref:less than HS)												
HS or Equiv	47.04		-19.22	113.31	43.56		-22.36	109.48	31.00		-35.15	97.15
Some college or tech school	132.48	**	47.67	217.3	132.99	**	49.41	216.57	119.90	**	36.76	203.04
College or Grad School	119.46	*	1.54	237.37	122.39	*	6.04	238.73	88.35		-27.92	204.62
Race/Ethnicity (ref: white)												
Black	-56.58		-198.63	85.46	-55.29		-198.09	87.51	-63.85		-206.47	78.77
Hispanic	66.08		-49.88	182.04	57.33		-60.29	174.94	41.05		-74.99	157.09
Other	-27.43		-196.05	141.19	-3.25		-171.03	164.53	-12.73		-182.69	157.22
Maternal Clinical Health												
Mental Health Problems					-73.38		-161.72	14.97	-8.10		-100.00	83.81
Prenatal Care (ref: w/I first 3 mo)												
After 3 months					-43.23		-110.99	24.52	-23.25		-89.36	42.87
Never					-97.71		-264.03	68.60	-81.34		-245.05	82.36
Gestational Diabetes					129.62	*	12.72	246.52	110.85	t	-6.78	228.48
Pre-eclampsia/Eclampsia					-315.96	***	-472.14	-159.79	-329.74	***	-483.68	-175.80
Obesity					140.85	**	37.95	243.75	144.87	**	41.77	247.98
HIV/STI					-32.78		-106.64	41.07	-28.26		-101.71	45.18
Child Gender					71.39	**	21.49	121.29	71.34	**	21.75	120.92
Maternal Pregnancy Substance Use												
Smoking									-162.60	***	-234.49	-90.71
Drugs									-52.42		-153.20	48.36
Alcohol									-88.71		-215.56	38.15

All models account for marital status, city, hospital and couple in the cluster statement

* P<0.05; ** P<0.01; ***P<0.001

Table II-12. Multivariate linear regression models predicting gestational age (weeks)
Outcome: Gestational Age (w)

	Model a N=2077			Model b N=2072			Model c N=2072			Model d N=2072		
	B	95% CI		B	95% CI		B	95% CI		B	95% CI	
Positive Couple Activities												
Mother	0.04	-0.08	0.15	0.00	-0.11	0.12	-0.01	-0.12	0.11	-0.01	-0.12	0.11
Father	0.03	-0.08	0.14	0.00	-0.11	0.11	0.00	-0.11	0.11	0.01	-0.10	0.12
Couple Conflict												
Mother	-0.01	-0.07	0.05	0.00	-0.06	0.06	0.01	-0.05	0.06	0.01	-0.05	0.07
Father	**-0.06** *	**-0.11**	**-0.01**	**-0.06** *	**-0.11**	**-0.01**	**-0.06** *	**-0.11**	**0.00**	**-0.05** *	**-0.11**	**0.00**
Partner Support												
Mother	-0.03	-0.12	0.07	-0.04	-0.14	0.06	-0.03	-0.13	0.07	-0.03	-0.13	0.07
Father	-0.04	-0.12	0.05	-0.04	-0.12	0.05	-0.05	-0.13	0.04	-0.05	-0.14	0.03
Relationship Satisfaction												
Mother	-0.01	-0.05	0.02	-0.01	-0.05	0.02	-0.01	-0.04	0.02	-0.01	-0.04	0.02
Father	-0.01	-0.04	0.02	-0.01	-0.04	0.03	-0.01	-0.04	0.03	-0.01	-0.04	0.03
Baby's Father at Birth	**0.63** ***	**0.30**	**0.96**	**0.56** ***	**0.23**	**0.89**	**0.51** **	**0.19**	**0.84**	**0.51** **	**0.19**	**0.83**
Relationship Duration (mo)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maternal Demographics												
Married	0.09	-0.15	0.32	-0.01	-0.29	0.26	0.03	-0.24	0.30	0.00	-0.27	0.27
Age (ref: 20-34)												
<20				0.12	-0.18	0.41	0.15	-0.15	0.45	0.15	-0.15	0.44
35+				-0.07	-0.48	0.35	-0.02	-0.42	0.39	0.01	-0.39	0.41
HH Income (in thousands)				0.00	-0.01	0.01	0.00	-0.01	0.01	0.00	-0.01	0.01
Education (ref: less than HS)												
HS or Equivalent				0.12	-0.16	0.40	0.08	-0.20	0.36	0.08	-0.20	0.36
Some college or tech school				0.07	-0.26	0.40	0.04	-0.29	0.37	0.03	-0.30	0.36
College or Grad School				0.09	-0.42	0.60	0.05	-0.45	0.56	0.02	-0.48	0.53
Parity				-0.04	-0.14	0.05	-0.05	-0.15	0.04	-0.05	-0.14	0.04
Paid w/ Medicaid or was Uninsured				-0.16	-0.40	0.08	-0.10	-0.34	0.15	-0.09	-0.34	0.15

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				Model 1			Model 2			Model 3		
Race/Ethnicity (ref: white)												
Black				-0.04	-0.57	0.49	-0.01	-0.55	0.52	-0.02	-0.56	0.53
Hispanic				0.06	-0.38	0.49	0.06	-0.38	0.50	0.03	-0.41	0.48
Other				-0.23	-0.73	0.27	-0.33	-0.84	0.18	-0.36	-0.88	0.15
Paternal Demographics												
Age				-0.02	-0.04	0.01	-0.01	-0.03	0.01	-0.01	-0.03	0.01
HH Income (in thousands)				0.00	-0.01	0.01	0.00	-0.01	0.01	0.00	-0.01	0.01
Education (ref:less than HS)												
HS or Equivalent				0.14	-0.12	0.41	0.15	-0.12	0.41	0.12	-0.16	0.39
Some college or tech school				0.36 *	0.03	0.70	0.35 *	0.02	0.69	0.32 t	-0.02	0.65
College or Grad School				0.41 t	-0.03	0.84	0.39 t	-0.04	0.82	0.33	-0.11	0.77
Race/Ethnicity (ref: white)												
Black				-0.13	-0.67	0.41	-0.14	-0.69	0.40	-0.17	-0.72	0.37
Hispanic				0.16	-0.30	0.61	0.13	-0.33	0.59	0.09	-0.37	0.55
Other				-0.03	-0.62	0.56	0.04	-0.55	0.63	0.02	-0.58	0.61
Maternal Clinical Health												
Mental Health Problems							-0.18	-0.52	0.17	-0.02	-0.39	0.35
Prenatal Care (ref: w/I first 3 mo)												
After 3 months							-0.05	-0.33	0.23	-0.01	-0.28	0.26
Never							-0.34	-1.23	0.55	-0.32	-1.20	0.57
Gestational Diabetes							-0.12	-0.50	0.25	-0.15	-0.52	0.22
Pre-eclampsia/Eclampsia							-1.31 ***	-1.91	-0.70	-1.32 ***	-1.92	-0.72
Obesity							0.13	-0.29	0.55	0.14	-0.28	0.56
HIV/STI							-0.33 *	-0.64	-0.02	-0.32 *	-0.63	-0.01
Child Gender							-0.04	-0.24	0.16	-0.04	-0.24	0.16
Maternal Pregnancy Substance Use												
Smoking										-0.14	-0.43	0.15
Drugs										-0.26	-0.68	0.17
Alcohol										-0.39	-0.89	0.10

All models account for marital status, city, hospital and couple in the cluster statement

* P<0.05; ** P<0.01; ***P<0.001

d.4 Interaction of Parental Reports

There were significant interactions between maternal and paternal reports of couple conflict in the association with birth weight (P=.01). No other interaction terms were significant at the P<0.05 level.

As shown in Figure II-2, I further explored the association between paternal reports of couple conflict with birth weight at three levels of maternal report of couple conflict controlling for all variables in the full model (model d): low: 1 SD below the mean; medium: the mean; high: 1 SD above the mean using Aiken and West (1991) as a guide.[129]

Effect of maternal report of couple conflict on birth weight at 3 levels of paternal report of conflict
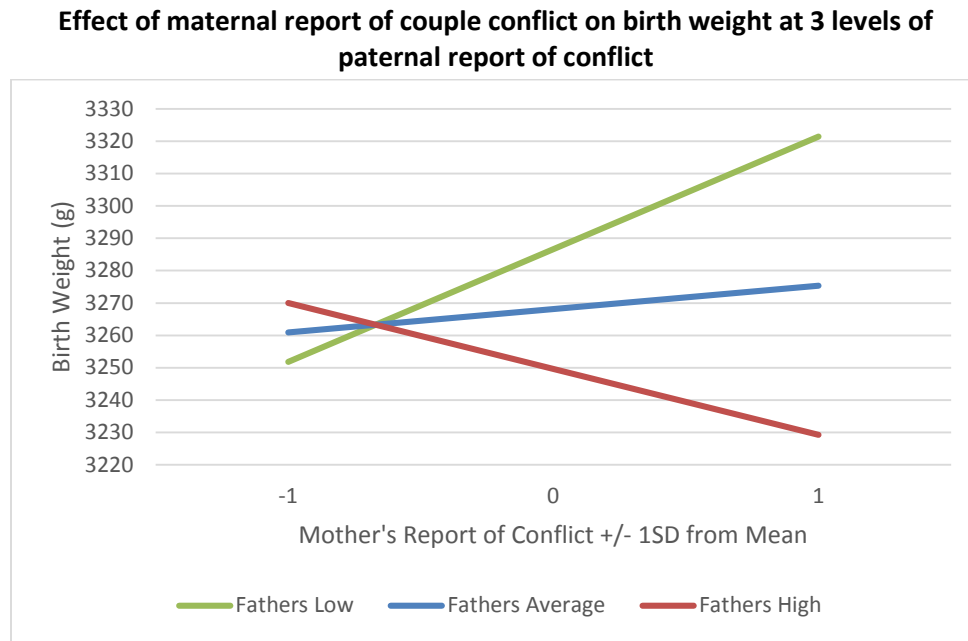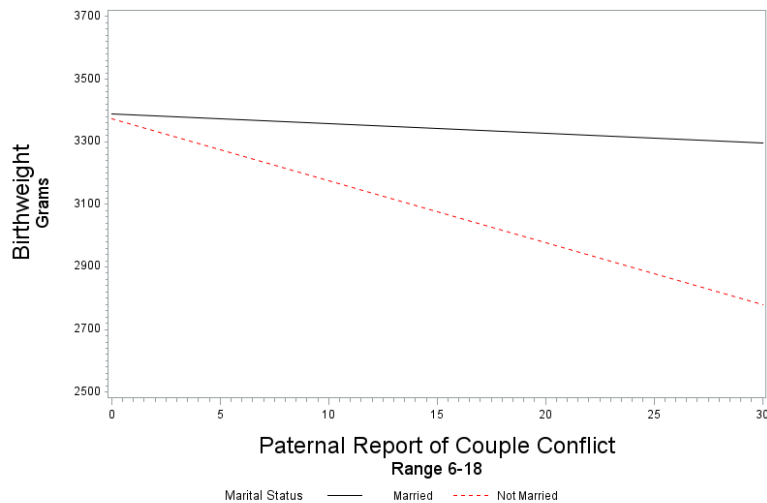
Figure II-2. Association between maternal report of couple conflict and birth weight at three levels of paternal report of couple conflict: low: 1 SD below the mean; medium: the mean; high: 1 SD above the mean.

d.5 Effect Measure Modification by Marital Status

There was a significant interaction between paternal report of couple conflict and marital status in the association with birth weight (B=27.27, 95% CI 1.08, 53.46, P=.04). When looking at simple slopes, among unmarried fathers, those who reported greater couple conflict had babies with lower birth weight on average (B=-14.92, 95% CI -28.24, -1.61, P=.03). The association between paternal report of couple conflict and birth weight was not significant among married fathers (Figure II-3).

To explore whether the association of paternal report of conflict with birth weight among unmarried men was driven by unmarried men reporting higher average levels of conflict, I added the interaction term between marital status and father's report of conflict into the interaction model with maternal and paternal report of couple conflict (section d.4). The interaction between maternal and paternal report of couple conflict remained significant, the effect size did not change substantially and the interaction between paternal report of conflict and marital status was not significant. This result suggests that the association between paternal report of conflict and birth weight is not driven by unmarried men reporting higher average conflict.

Figure II-3. Effect measure modification of the association between paternal report of couple conflict and birth weight by marital status.

The interactions between marital status and maternal and paternal reports of conflict in the association with gestational age were not significant.

There was a significant interaction between relationship duration and marital status in the association with birth weight (B=-1.07, 95% CI -2.10, -0.04, P=.04). When looking at simple slopes, among unmarried couples, those who reported greater relationship duration had babies with greater birth weight on average (B=0.75, 95% CI .08, 1.42, P=0.03). The association between relationship duration and birth weight was not significant among married couples (Figure II-4).

Association of Relationship Duration with Birthweight by Marital Status

Marital Status ——— Married ------ Not Married
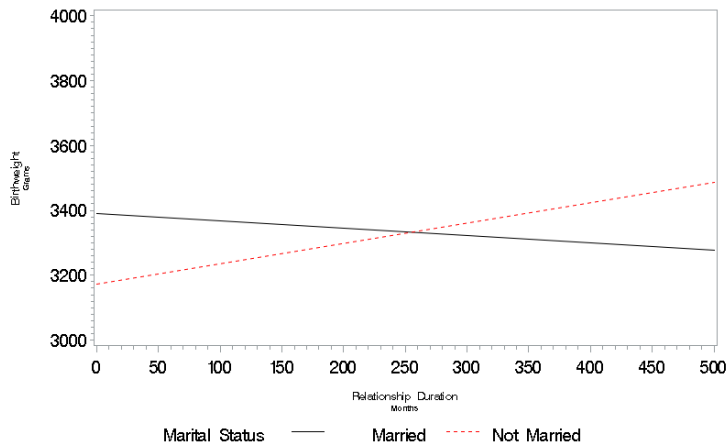
Regression Equation:
chbthwtg(m1a10:1) = 3391.61 − 0.228806*MRELDUR
chbthwtg(m1a10:2) = 3171.3 + 0.629448*MRELDUR

Figure II-4. Effect measure modification of the association relationship duration and birth weight by marital status.

Marital status did not interact significantly with any other relationship quality predictor variables when predicting birth weight.

Marital status did not interact significantly with any relationship quality variables when predicting gestational age at birth.

d. Discussion

Among this national sample of married and unmarried parents in a relationship, the father's report of conflict with his partner over the previous month and the father's presence at birth were both significantly associated with having a baby with a lower birth weight and an earlier gestational age at birth after controlling for maternal and paternal demographic factors, maternal pregnancy clinical health and maternal substance use during pregnancy. The effect sizes of findings were substantial. Babies born to fathers who fell into the highest quartile of conflict were 69.68 grams lighter than babies born to fathers who fell into the lowest quartile of conflict after controlling for all covariates. Additionally, babies born to fathers who were not present at the birth were nearly 99 grams lighter after controlling for all covariates. Estimates show that babies born to *light* smokers during pregnancy are on average 160 grams lighter at birth than babies born to non-smokers. Therefore, these effect sizes are not neglegible.[130]

Conflict in a relationship and the association with birth outcomes

Conflict in a romantic relationship can cause serious stress among both members of an expectant couple and the evidence from this study supports the hypothesis that this conflict can have a deleterious effect on two important birth outcomes: birth weight and gestational age. A plethora of studies have shown that women's experiences of stress during pregnancy are associated with PTB[27,28,31–33] and LBW.[27,31,34,35] The findings from the current research show that men's experiences of conflict within a relationship have a significant association with negative birth outcomes, suggesting that men's experiences and feelings when they are expecting a baby may have a unique contribution to birth outcomes.

Recent evidence has demonstrated that elevated levels of stress hormones, such as cortisol, among pregnant women are associated with lower birth weight[131] and lower gestational age at birth.[132]

A recent study by Feinberg and colleagues (2013), however, showed that salivary cortisol levels were elevated among both partners in an expecting couple in response to conflict within their relationship. Emotional contagion research has shown that feelings and emotions among members of a romantic couple tend to spill-over from one member of the couple to the other.[133] Thus, men's and women's stress reactions may converge and ultimately have an interactive effect on birth outcomes. Consistent with this research, the results of the interaction between maternal and paternal reports of conflict suggest that the average birth weight was the lowest when both parents reported high levels of conflict with their partner. Further, the results suggest that the mother's report of conflict is protective--when mothers perceived low levels of conflict, the father's report of conflict did not have an association with birth weight; however, when mothers reported high levels of conflict, the greater the father's the report of conflict the worse it was for the baby.

Differences in the association of relationship quality with birth outcomes by marital status

Many studies have demonstrated that babies born to married parents, on average, have greater birth weight and a longer gestation compared to babies born to unmarried parents.[66] We know little, however, beyond associated socioeconomic status, about what about being unmarried or married affects birth outcomes. The results from this study show that paternal reports of conflict were only significantly predictive of lower birth weight among *unmarried* fathers. This finding is consistent with previous qualitative research showing that married and unmarried couples perceive tensions in their relationship differently. Waller (2008) found that unmarried couples felt tensions were a greater risk to the stability of their relationship.[107] Conflict in a relationship is a fact of life; however, the results of this study may suggest that couple conflict may cause more stress among unmarried couples than married couples, and therefore have a more negative association with birth outcomes among unmarried couples.

In addition, relationship duration was only predictive of greater birth weight among *unmarried* couples in this study. It is possible that being married is a useful indicator of a committed relationship with more resources to support a healthy pregnancy; however the story is more nuanced among unmarried couples where the duration of the relationship may matter more. This finding may suggest that among unmarried couples, those who have been in a relationship longer may have developed healthier relationships (e.g. better ways to deal with conflict) that can support a healthier pregnancy than unmarried couples who have known each other for a shorter period of time.

The association of the baby's father's presence at birth with birth outcomes

In the current study, the baby's father's presence at the birth was significantly associated with both the baby's birth weight and gestational age at birth among married and unmarried couples alike. In fact, the magnitude of the association with birth weight is similar to the effect of light smoking during pregnancy on birth weight.[130] Whether the baby's father was present at the birth may be a useful way to discern between pregnancies that are more at risk for negative birth outcomes (and potentially poor child health outcomes later). The baby's father's presence at the birth may be a marker of the father's involvement and support, both material and emotional, during the pregnancy. As theorized by Alio et al (2010), support from the baby's father during pregnancy may decrease maternal stress and encourage healthy behaviors, ultimately leading to better birth outcomes.[68]

A study by Teitler (2001) among unmarried couples only within the Fragile Families study, however, did not find that the father's presence at the hospital for the baby's birth or visited around that time was associated with the risk for low birth weight.[103] Teitler (2001) did find that the father's presence at the birth had a positive association with maternal health behaviors, however.[103] Thus, this study is unique in that it found a significant association between the baby's father's presence at the birth and both birth weight and gestational age among the Fragile Families population after controlling

for maternal and paternal demographics, and maternal clinical health and substance use during pregnancy. The differences between Teitler's (2001) findings and the findings in this study are likely due to the fact that 1) Teitler's analysis only included unmarried couples, while this analysis uses all couples in a relationship; 2) Teitler used a dichotomous measure of low birth weight, while this study looked at the continuous forms of birth weight and gestational age abstracted from the medical record and 3) Teitler used the mother's report of whether the father was present at the birth, whereas this study uses the father's report of his own actions (though Teitler reports that the results were substantively the same using father report).

Limitations

While this study has many strengths, it is not without limitations. This secondary data analysis is limited by the study design and the measures collected. The timing of assessments is of some concern. Parents' report of their relationship quality was assessed shortly after the birth of their baby, raising concern over the issue of reverse causality. It is possible, though unlikely, that having a child born with a low birth weight or too early could cause parents to reflect more negatively about their relationship with their partner due to the stress that they are under. In addition, the fathers and mothers were not always interviewed on the same day, thus their perspectives on their relationship may differ due to the elapsed time and events that may have occurred within this time, rather than true differences in how they perceived their relationship quality. A sensitivity analysis was conducted comparing the results among couples that were interviewed within one month of each other versus the more than one week, and the results among the two groups were substantively the same.

As with all observational studies, there could be important omitted confounders that could explain the relationship between relationship quality factors and the birth outcomes. Unfortunately, due the limitations of the study design and measures collected, we cannot parcel out unmeasured

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confounding of the association between relationship quality and birth outcomes by some other parental characteristic (e.g. personality, depression) that would affect both the exposure and outcome. Future studies would be strengthened by abstracting birth outcomes from medical records, measuring reports of relationship quality at multiple time points during pregnancy, and measuring other personality and affect variables during pregnancy. This study would also be strengthened by the inclusion of a partner support variable that had higher reliability,

Strengths

Despite these limitations, this study provides an expanded and more comprehensive assessment of relationship quality and its association with birth outcomes compared to previous studies which have been limited to assessing paternal social support, markers of paternal involvement (e.g. father's name on birth certificate, paternal financial contributions) and intimate partner violence.[68,71,103,134] The addition of a single-item maternal report of being a victim of physical abuse by the baby's father was added to the full models assessing the associations between all relationship quality predictors and each birth outcome; however the effect estimates were unchanged.

This study also included direct report of relationship quality from the fathers, while most studies use reports only from mothers, and included both maternal and paternal reports within the same statistical model while accounting for clustering by couple. This study was thereby able to show that men's experiences and feelings when they are expecting a baby may have a unique contribution to poor birth outcomes—something that no other study has done.

Implications for Future Research and practice

This study suggests that dimensions of relationship quality, and most saliently couple conflict and the baby's father's absence at the birth, are associated with birth outcomes at a level that is nearly commensurate with the effect of light smoking on birth outcomes. Further, in this study, men's report of his experiences of conflict were associated with birth outcomes while the mother's reports acted only in concert with her partner's report. Our nation has spent the last several decades focusing on changing maternal behaviors (e.g. smoking during pregnancy and attending prenatal care) to improve population rates of low birth weight and preterm birth with little luck. Programs and policies that not only address the importance of healthy romantic relationships, but that also include both members of an expectant couple, may help support healthier pregnancies and improve the rates of negative birth outcomes.

Chapter III.   *Parental Stress during Pregnancy and Birth Outcomes among Children in the Parenting and Relationship Transition and Risk Study*

a. Introduction

Preterm birth (PTB; <37 weeks gestation) and low birth weight (LBW; <2,500 grams) are leading causes of infant mortality in the United States (U.S.)[110] and infants born pre-term and/or with a LBW are at increased risk for negative health and developmental issues as they grow.[111,112] Of all infants born in the U.S., 11.3% are born preterm and 8.0% are born with a low birth weight.[39] Among teens aged 15-19, the rates of PTB and LBW are even higher at 13.0% and 9.3% respectively.[39] Among babies born to 15 year olds, 17.3% are born preterm and 10.2% have a low birth weight.[39] The higher rates of these adverse birth outcomes among teens has been attributed to maternal risk factors associated with teenage pregnancy, such as low socioeconomic status, minority status, and inadequate prenatal care.[135,136] A retrospective cohort study of 3,886,364 pregnant women comparing teens to adults, however, found that teen pregnancy increases the risk for adverse birth outcomes even after adjusting for these factors,[137] suggesting that other factors are also at play.

Stress as a predictor of birth outcomes

Epidemiological evidence shows that maternal stress during pregnancy is consistently predictive of negative birth outcomes, including PTB[27,31–33,138] and LBW. [27,31,34,35] In fact, the American Congress of Obstetricians and Gynecologists recommends screening for psychosocial stress as part of prenatal care, citing that it may play a role in PTB and LBW.[37] Adolescents and young adults experience stressors that emanate from various life domains, including close relationships and personal hardships, but for adolescents and young adults who are racial and/or ethnic minorities and from a low socioeconomic status (SES), daily stressors often extend beyond these typical developmental challenges. This population is disproportionately affected by other chronic stressors, such as neighborhood problems (e.g. crime, poor infrastructure), racism and discrimination.[38] Thus, stress may have a substantial effect on birth outcomes among low SES youth of color.

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Conceptually, stress is an interactive process in which environmental demands exceed one's adaptive capacity, resulting in three types of responses that can lead to poor health outcomes and, therefore, serve as mediators between experiences of stress and adverse birth outcomes: 1) behavioral, 2) cognitive/psychological and 3) physiological responses.[40,41,139] Experiences of stress are hypothesized to affect birth outcomes through these three inter-related stress-response processes, as detailed below.[44]

First, negative health behaviors, such as smoking or substance use, can serve as coping mechanisms for stress. [41,140] Studies show that stress consistently predicts negative health behaviors (e.g. smoking, substance use, poor dietary habits, physical inactivity) among pregnant women, [46,139] which are also consistently related to adverse birth outcomes. For example, smoking and substance use are well-documented causes of PTB,[19] and inadequate nutrition and smoking are known risk factors for LBW.[20,139]

Second, negative appraisals or perceptions of stress are thought to cause cognitive and psychological responses, which subsequently directly affect both behavioral and physiologic responses, and risk for physical and mental disease.[40,51] These psychological responses include depressive symptoms, which have been independently linked with negative birth outcomes.[51]

Third, two physiologic pathways through which stress and the cognitive and psychological responses may affect birth outcomes include the neuroendocrine system—specifically the hypothalamic-pituitary-axis (HPA), which regulates the physiological response—and the immune/inflammation system. Under conditions of chronic psychological stress, the HPA axis can become dysregulated, leading to chronically elevated levels of glucocorticoids in the system,[138] which could signal a series of endocrine events leading to PTB.[138] Stress may cause preterm birth through the immune/inflammation pathway by increasing maternal susceptibility to infection,[27] causing the release

of catecholamines[27] or causing an inflammatory response that triggers contractions, cervical ripening and membrane rupture.[29]

Dunkel Schetter and Lobel[139] offer the most comprehensive framework depicting the pathways through which maternal stress may influence PTB and LBW (Figure III-1). The conceptual model describes how both chronic (persistent or recurrent difficulties over the long term) and acute (discrete threats that are shorter term) stressors can influence birth weight and gestational age at delivery. Dunkel Schetter and Lobel's framework synthesizes findings from a large literature examining individual stress components and birth outcomes. Previous studies, however, have been inconsistent in terms of how stress is conceptualized,[78] if a conceptual model is attended to at all, and none assess all components of this model, including stress exposures, appraisal, responses and birth outcomes.
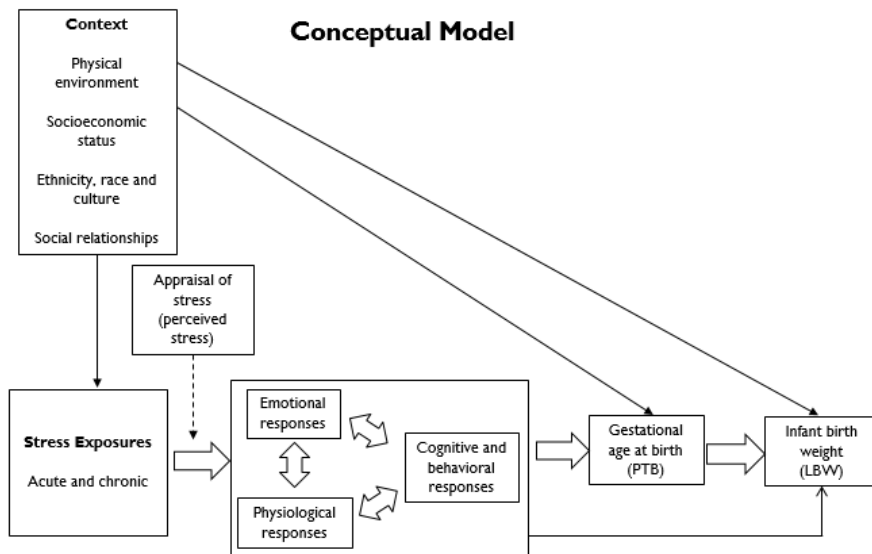

Figure III-1. Conceptual model of stress and birth outcomes. Reproduced from Pregnancy and Birth Outcomes: A multilevel analysis of prenatal maternal stress and birth weight. In: *Handbook of Health Psychology (2nd Edition)* (p.451), by Dunkel-Schetter and Lobel, 2012, New York: Springer.[43]

Sources of stress

The stressors that expectant parents experience may come from multiple sources, including individual experiences (e.g. job loss), interpersonal exposures (e.g. conflict in a steady relationship), neighborhood conditions (e.g. crime in neighborhood), and societal context (e.g. racism). These stressors are common among low income populations and racial and ethnic minorities due to social and economic structures and influences.[141] These stressors could influence birth outcomes through the behavioral, psychological and physiological pathways described above, and a large body of literature has examined how maternal experiences in each of these domains is associated with negative birth outcomes. For example, checklist inventories of acute major life events mothers experienced during pregnancy have been associated consistently with lower infant birth weight and gestational age at birth.[35,139] Maternal perception of neighborhood problems during pregnancy have been significantly associated with lower infant birth weight,[142] with the hypothesis that living in a disadvantaged neighborhood causes stress by increasing the likelihood of experiencing stressful life events and exposing individuals to neighborhood disorder.[143] Discrimination and racism are also thought to cause chronic stress; however, the findings on the effects of maternal experiences of discrimination on birth outcomes have been mixed. Some studies exploring whether maternal experiences of discrimination during pregnancy are associated with LBW and PTB have found a significant association (e.g. Dominguez et al.,[144] Collins et al.[145]), while others have not (e.g. Lu and Chen,[146] Shiono et al.[147]). Most studies have assessed the influence of these different sources of stressors on birth outcomes individually, despite acknowledgement that birth outcomes are the result of conjoint effects of multiple factors.[139]

Stress among expectant adolescents and young adults

While stress cuts across all populations, stress may have a larger deleterious effect on expectant adolescents and young adults for several reasons. First, adolescents and young adults are developing

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and may lack effective coping skills and resources. [94] Second, pregnancy itself can be a stressor for any

expectant parent,[148] but the transition to parenthood may be exceptionally stressful for adolescents

because they are concurrently confronting the challenges of parenthood and adolescent

development.[149] Pregnancy can also give rise to or exacerbate other stressors that may be more

common among adolescents and young adults compared to older expectant parents (e.g. financial

concerns for supporting a new baby, relationship problems).[96] Third, during adolescence and young

adulthood, social relationships outside of the family, including romantic relationships, become

increasingly important.[97] An adolescent's romantic partner plays an important role in the attachment,

support, and caregiving behavioral systems.[98] Most expectant adolescents and young adults are

involved with the baby's father during pregnancy;[65,150] however they are still learning to interact with

their partner and developing their relationship skills[98] and therefore negotiating this relationship may be

a significant source of stress for adolescents compared to older adults.

Paternal Influence on birth outcomes

A large body of literature has documented that women's experiences of stress during pregnancy

are associated with negative birth outcomes;[27,31–34,138] however, research has also demonstrated that

the perceptions of stress and coping strategies are affected by social relationships.[62] The relationship

with the baby's father is often an important social relationship in an expectant woman's life, regardless

of marital status. Over 80% of unmarried pregnant women are in a relationship with the baby's father

during pregnancy.[63] Thus, a woman's male partner likely has a substantial influence on the expectant

mother during this time.

Despite the importance of male partners during pregnancy, very little research has explored

paternal influences on birth outcomes.[66] Research examining the impact of stress on birth outcomes

that includes paternal factors has been limited to maternal reports of paternal involvement and support,

and these measures are often crude (e.g. the extent to which there is a father's name on the birth certificate).[68,71] Researchers and clinicians have almost entirely focused on how women's experiences are associated with birth outcomes; however, men's experiences of stress during his partner's pregnancy may also influence birth outcomes through his effects on maternal psychosocial factors.[67]

In fact, substantial evidence supports the theory that among couples, stress experienced by one member can affect the well-being of the other member.[72] For example, a woman's partner's stress with his friends may impact her own depression.[72] Much of this research has focused on the cross-over of one's work stress to the other's well-being[72] and relationship satisfaction (e.g. Neff[74]); however no studies have documented this process among expectant couples, and none have assessed the impact of paternal stress during pregnancy on birth outcomes via effects on maternal well-being.

Current Study

The current study aims to, first, investigate the association between maternal and paternal stress during pregnancy and the gestational age at birth and birth weight of their baby among adolescent and young adults from low SES. Second, this study aims to explore whether the associations of maternal and paternal experiences of stress with birth outcomes, if evident, are mediated by maternal depressive symptoms.

b. Methods

b.1   *Data Source*

Overview and Sampling Procedures

Data for this analysis come from baseline interviews of 296 expectant young couples who participated in the Parenting and Relationship Transition and Risk Study (PARTNRS) between 2007 and 2011, and their birth hospitalization medical records. Women were recruited from obstetrics and gynecology clinics and an ultrasound clinic in four university-affiliated hospitals in southern Connecticut. An initial screening included only women who reported they were in a romantic relationship with the baby's father.

If the baby's father was not present at the time of screening, research staff asked for permission to contact him to explain the study. If the expectant woman was willing, research staff provided informational materials for the baby's father and asked the baby's mother to talk to him about the study. Research staff contacted the baby's father to answer any questions and, if he was interested, scheduled an appointment for the couple's baseline interview.

Participants

Inclusion criteria to participate in the baseline interview for both men and women were: (a) pregnant or partner was pregnant after 24 weeks gestation; (b) women were age 14-21 years and men were age ≥ 14; (c) both reported being in a romantic relationship with each other; (d) both reported being the biological parents of the unborn baby; (e) both agreed to participate in the study and (f) both were able to speak English and/or Spanish.

Study Procedures

A research staff member obtained Informed consent at the baseline appointment, which was conducted after 24 weeks gestation but before the baby was born. The couples separately completed a structured interview via audio computer assisted self-interviews (ACASI) during this baseline appointment. ACASI allows respondents to listen over headphones to spoken questions that are also displayed on the computer's screen.

After the baby's due date, a research assistant went to each affiliated hospital and collected birth outcome information from each participating woman's medical record. A small number of women did not deliver at an affiliated hospital.[d] In this case, the research assistant collected basic birth outcome information (e.g. birth weight, gestational age at delivery) directly from the baby's mother by calling her on the telephone. The Yale University Human Investigation Committee and the Institutional Review Boards (IRB) at study clinics approved all procedures. The CUNY Graduate Center granted IRB approval to use the de-identified PARTNRS data as well. Each participant (mothers and fathers separately) was paid $25 for his or her voluntary participation in this interview.

b.2 Measures

Please see Appendix III-1 and Appendix III-2 for detailed item descriptions, and estimates of the validity and reliability of the measures used in the analyses for this chapter. All measures for this aim were assessed among both mothers and fathers at the baseline interview during pregnancy (after 24 weeks gestation).

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[d] The number of cases where the birth outcome information was not abstracted from the mother's medical record, but rather from the mother's report, is unknown due to a lack of documentation in study records; however, it is estimated at less than 5%.

Assessment of stress

Table III-1 shows a detailed description of the relationship quality predictor variables. Three different stress measures were assessed via ACASI at the baseline interview and included in this analysis. Stressful life events over the previous six months were measured using a modified 11-item version of Brugha and Cragg's Life Events Scale (LES).[151] Participants reported whether they experienced each item (yes/no), such as suffering a serious injury or assault and having money problems. Experiences of discrimination (referring to experiences "in general") were measured using Essed's Daily Life Experiences Scale.[152] Participants responded on a 6-point scale ranging from "Never" to "Once a Week Or More" for each item, such as "In general, how often are you observed or followed while in public spaces?" and "In general, how often are you ignored, overlooked, or not given service (in a restaurant, store, etc.)?" Perceived stress over the past month was measured using ten items from Cohen's Perceived Stress Scale.[88] Participants indicated how often they felt each item on a 5 point scale ranging from 0="never" to 4="very often," such as "In the past month, how often have you felt unable to cope with all of the things you had to do?" and "how often have you felt that difficulties were piling up so high that you couldn't overcome them?"

Assessment of Birth Outcomes

The baby's birth weight and gestational age at delivery were abstracted from the mother's medical record at delivery (or from the baby's mother if not available as described under *Study Procedures*). Gestational age was recorded in weeks and birth weight was recorded in grams.

Covariates

Several covariates were accounted for during model building and are described in detail in Appendix III-1. A priori hypothesized demographic confounders included maternal and paternal household income, age, work/student status, race/ethnicity, maternal parity and baby's gender.

Clinical risk factors were also a priori hypothesized confounders. A summary score of five clinical risk factors ranging from 0 to 5 was computed due to the low numbers of women with any one factor. Women were given a value of 0=No and 1=Yes for each of the five clinical risk factors: obese before pregnancy (based on BMI >30 calculated from self-report of pre-pregnancy weight and height); positive Chlamydia and/or Gonorrhea test at any point during pregnancy (LCR test during study visit in the late second or early third trimester); medical record indication of pre-eclampsia; medical record indication of gestational diabetes; and self-report on whether she received any prenatal care prior to the interview, which was within the third trimester.

Smoking and alcohol use during pregnancy were measured using an adapted, 7-item version of the Recreational Drug Use Scale.[153] Frequency of use during the past three months for both substances were assessed using a 5-point Likert scale, ranging from 0 = "Never" to 4 = "Every Day." This study dichotomized the responses to 0 = "Never" and 1 = "At least some."

Mediator

Depressive symptoms over the past week were measured using 15 of the 20 items in the Center of Epidemiological Studies-Depression Scale (CES-D).[91] Participants responded on a 4-item scale ranging from 0="Less than 1 day" to 3="5-7days". Items included "during the past week I had crying spells" and "during the past week I felt depressed." Responses were summed to form a continuous depressive symptom score ranging from 0 to 45.

Table III-1. Stress predictor and mediator variables

Construct	Measure	Description	Response Scale	Scoring
Stressful Life Events	Brugha and Cragg Life Events Scale (LES)[151] (adapted)	11 items assessed experiences of stress (e.g. having an illness, death in the family)	1=Yes, 0=No	-Responses summed to form an index -Higher scores correspond to more events (range: 0-11)
Discrimination	Essed Daily Life Experiences Scale[152] (adapted)	20 items assessed experiences of discrimination (e.g. not being given service in store, being called insulting name).	6-point scale ranging from 0 ("Never") to 5 ("Once a Week or More")	-Responses summed to form a continuous scale -Higher scores correspond to more discrimination (range: 0-100) (α = 0.92 w, 0.94 m)
Perceived Stress	Cohen Perceived Stress Scale[88]	10 items assessed degree situations are stressful (e.g. how often nervous or stressed; unable to control important things)	5-point scale ranging from 0 ("Never") to 4 ("Very often")	-Responses summed to form a continuous scale -Higher scores correspond to more perceived stress (range: 0-40) (α = 0.77 w, α = 0.74 m)
Depressive Symptoms	Center of Epidemiological Studies-Depression Scale (CES-D).[91] (adapted)	15 items assessed how often experienced the depressive feeling or thought (e.g. I felt depressed, had crying spells) -Five behavioral manifestations of depression items were removed	4-point scale ranging from 0 ("Rarely or none of the time (less than 1 day") to 3 ("Most of the time (5-7 days)")	-Responses summed to form a continuous scale -Higher scores correspond to more depressive symptoms (range: 0-45) (α = 0.77 w, α = 0.74 m)

b.3 Statistical Analysis

I generated descriptive statistics of sample characteristics using IBM SPSS Statistics V22 (IBM Corporation, Armonk, NY). I used IBM SPSS AMOS V22 to construct a latent stress measure from the three stress measures and complete all remaining analyses. I then used structural equation modeling (SEM) to test the extent to which the maternal and paternal latent stress variables predicted gestational age at birth and birth weight after adjusting for a priori hypothesized confounders. I further examined whether maternal depression explained any of the association between the latent stress variables and birth outcomes to test for it as a mediator. SEM simultaneously assesses direct, indirect and total effects of a system of variables on an outcome. It can be tailored to account for clustering of data within couples, can accommodate multiple correlated outcomes (such as birth weight and gestational age in this study) and can include latent variables.[154,155] Therefore, SEM was ideal for use in this study.

Sample

Of the 296 participants, seven men had substantial missing data (i.e. had at least one stress measure missing). Maternal and paternal demographic characteristics did not differ significantly among the men with missing data on the stress variables compared to those who were not missing data (not shown). Therefore, couples where men were missing stress data were excluded. Fourteen additional couples were missing data for birth weight and gestational age at delivery and another three were missing data on birth weight. Maternal and paternal demographic characteristics did not differ significantly between the couples missing birth outcomes data and those with this data (not shown). These 17 couples were also excluded. Two couples had multiples and due to the greater likelihood that these babies would be born early or small due to being a multiple alone, these couples were excluded. The final sample size was 270 couples who gave birth to 270 infants.

One birth weight outlier was identified using the Outlier Labeling Rule as described by Hoagline, Iglewicz and Tukey.[156] The value for this case (915 grams) was Windsorized to the next lowest value (1,390 grams).[157] Four gestational age outliers were identified using the Outlier Labeling Rule. The values for these cases (27.14-34.00 weeks) were Windsorized to the next lowest value (34.57 weeks).[56]

Model Specification and Identification

I calculated Cronbach's alphas for discrimination, perceived stress and depression scales to estimate the reliability of these scales (Table III-1, column 5). Alpha values were high (ranging from 0.74 to 0.94). I did not calculate a Cronbach's alpha for the stressful life events measure because, as an index, a participant's endorsement of one item should not necessarily be related to the endorsement of another item if the events are independent.[158]

Because participants were part of couples (i.e. dyads), clustering effects were likely. I estimated Spearman's rank correlation coefficient (rho) to determine the collinearity of dyad members' data (Table III-2). In the structural equation model, covariances were drawn between the error terms of the maternal and paternal stress variables to account for clustering as recommended by Kenny et al. (2006).[159]

Table III-2. Correlations between maternal and paternal stress predictor variables

Spearman's Rho				
		Men		
		Stressful life events	General discrimination	Perceived Stress
Women	Stressful life events	.22**	.06	.10
	General discrimination	.10	.15*	.12*
	Perceived Stress	.10	.03	.29**

*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

Estimation

The model was estimated using maximum likelihood, which compared the likelihood of the given model to the likelihood of a model with perfect fit. This method was preferred because it is asymptotically unbiased and is scale invariant.[160] Unstandardized coefficients were calculated to allow for comparison of coefficients between mothers and fathers.[159]

Testing

Global fit indices recommended by Bollen and Long (1993),[161] and Blunch (2008)[155] were assessed. The overall chi squared test of model fit was calculated; however, because this fit index is sensitive to sample size, the Tucker Lewis Index (TLI), the Root Mean Square Error of Approximation (RMSEA) and the p value of close fit (PCLOSE) were also calculated.[155]

c. Results

c.1 Descriptive Statistics

The sample is described in detail in Table III-3. On average, the women in this study were 18.7±1.6 years old and their male partners were 21.3±3.9. The average age difference was 2.6 ±3.3 years. Most of the participants were black (38.2% women and 46.7% men) or Hispanic (40.7% women and 38.2% men). Just over half of the women were in school or working, while nearly three-quarters of the men were in school or working. The average annual household income of women and men was quite low ($13,567 and $17,518, respectively). The average birth weight of the baby was 3,219.2±528.2 grams and 5.6% had a low birth weight. The average gestational age at delivery was 39.3±1.8 weeks and 7.8% of babies were born preterm.

Table III-3. Characteristics of Sample Population (N=270)

	MOTHERS			FATHERS		
	N	Mean	SD	N	Mean	SD
Birth Weight (g) of baby	270	3219.19	528.23			
Gestational Age at delivery (weeks)	270	39.25	1.82			
Age	270	18.69	1.62	270	21.26	3.86
Household Income (1,000K)	268[e]	13.59	15.59	270	17.61	22.03
Gestational age at first interview	270	28.92	5.25	270	28.92	5.26
	N	%		N	%	
Current pregnancy is first child	215	79.30		205	75.40	
Baby Boy (this pregnancy)	140	51.85				
In school or working (FT or PT)	158	58.52		198	73.33	
Race/Ethnicity						
Black	103	38.15		126	46.67	
Hispanic	110	40.74		103	38.15	
White	46	17.04		29	10.74	
Other	11	4.07		12	4.44	
Marital Status/Living Situation						
Living alone and not married	107	39.26		82	30.37	
Not Married, Living with Partner[f]	126	46.67		130	48.15	
Married	38	14.07		52	19.26	
Separated/Divorced	0	0.00		2	0.74	
Widowed	0	0.00		4	1.48	
Obese before pregnancy	61	22.59				
Cigarette use during pregnancy	41	15.19				
Alcohol use during pregnancy	13	4.82				
Any prenatal care to date	257	95.19				
Pre-Eclampsia	2	0.74				
Gestational Diabetes	3	1.11				
STI during pregnancy[b]	13	4.89				
	N	Mean	SD	N	Mean	SD
Stressful Life Events	270	2.11	1.94	270	2.34	2.22
General Discrimination	270	0.85	0.81	270	1.05	1.02
Perceived Stress	270	16.73	6.15	270	15.35	6.27
Depressive Symptoms	270	10.53	7.34	270	8.94	6.40

[e]Data is missing for respondents who refused to answer these questions or provide a sample.
[f]Marital status/living situation may not match between males and females because each individual reports his/her own answer and there is some discrepancy in how members of the couple reported their situation.

Table III-4. Correlations of Study Variables among Women

	Variable Name (Women)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Birth Weight (g)	--																			
2	Gestational Age (weeks)	.44**	--																		
3	Stressful Life Events	-.08	.03	--																	
4	General Discrimination	-.04	.00	.46**	--																
5	Perceived Stress	-.05	-.05	.25**	.39**	--															
6	Depressive Symptoms	-.15*	-.06	.19**	.27**	.68**	--														
7	Age	-.03	-.05	-.13*	-.10	-.11	-.15*	--													
8	Income	.14*	.10	.00	.05	.00	-.14*	.18**	--												
9	In School or working (FT or PT)	.03	.02	.02	.05	.11	.07	-.21**	.10	--											
10	Black	-.09	-.02	-.03	-.09	.01	.06	.03	-.05	.03	--										
11	Hispanic	.07	.01	-.05	-.11	-.03	-.01	-.12	-.05	.09	-.65**	--									
12	White	.07	-.01	.09	.14*	.00	-.08	.11	.12*	-.16**	-.36**	-.38**	--								
13	Not married nor living with partner	-.07	.00	.02	-.01	.03	.14*	-.04	-.02	.15*	.10	-.03	-.06	--							
14	Not married, living with partner	.08	.07	.01	.02	-.03	-.11	.08	.01	-.07	-.06	.01	.05	-.75**	--						
15	Married	-.01	-.11	-.05	-.01	.00	-.05	-.05	.02	-.11	-.05	.03	.01	-.33**	-.38**	--					
16	BMI before pregnancy	.13*	-.04	.05	.06	-.01	.02	.02	.06	.02	-.01	.03	-.01	.03	-.07	.05	--				
17	Clinical risk score	.06	-.03	.05	.02	.01	.04	.10	-.03	.02	-.07	.04	.05	-.05	-.01	.08	.53**	--			
18	Pregnancy is first child	-.04	-.08	-.02	-.14*	-.04	-.08	.31**	.02	-.16*	.04	-.01	-.02	-.08	.07	.01	.05	.04	--		
19	Baby boy	.17**	.09	-.06	-.07	-.10	-.13*	-.05	.01	-.13*	-.02	.04	.00	-.06	.05	.01	.03	.01	-.05	--	
20	Cigarettes during pregnancy	-.11	.07	.04	.04	.00	-.02	.09	-.06	-.10	.01	-.25**	.19**	-.04	.02	.04	-.14*	-.08	.10	-.05	--
21	Alcohol during pregnancy	.07	.08	.05	.04	.06	.05	.05	.12	-.20**	-.03	-.01	-.01	-.07	.03	.06	.03	-.04	-.11	.01	.10

*P<0.05 **P<.01

Table III-5. Correlations of Study Variables among Men

	Variable Name (Men)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Birth Weight (g)	--																		
2	Gestational Age (weeks)	.44**	--																	
3	Stressful Life Events	.01	.04	--																
4	General Discrimination	.13*	.07	.34**	--															
5	Perceived Stress	.04	.01	.24**	.34**	--														
6	Depressive Symptoms	.00	-.02	.07	.17**	.61**	--													
7	Age	-.03	-.03	.05	.02	.12*	.07	--												
8	Income	.02	.00	-.13*	-.05	-.19**	-.20**	.12*	--											
9	In School or working (FT or PT)	.01	-.08	-.16*	.00	-.15*	-.11	-.04	.31**	--										
10	Black	-.10	.00	.11	.08	-.01	-.03	.05	-.05	-.12*	--									
11	Hispanic	.00	-.07	-.17**	-.15*	.02	.04	-.10	-.05	.06	-.73**	--								
12	White	.17**	.09	.09	.08	-.03	-.02	.14*	.19**	.07	-.32**	-.27**	--							
13	Not married nor living with partner	-.12*	.03	-.05	-.06	.02	.00	.05	.00	-.03	.17**	-.12	-.03	--						
14	Not married, living with partner	.09	.08	.03	.11	.02	-.01	-.01	-.04	.01	-.08	.07	.00	-.65**	--					
15	Married	.06	-.10	.05	-.03	-.04	-.02	.00	.07	.04	-.10	.06	.04	-.33**	-.47**	--				
16	BMI before pregnancy	.10	.01	-.06	.08	.04	-.01	.20**	.03	.03	-.11	.12	.02	-.11	.08	.05	--			
17	Pregnancy is first child	-.01	.08	.02	.06	.13*	.19**	.26**	-.16**	-.18**	.12*	-.09	-.05	.04	-.04	.01	.05	--		
18	Baby boy	.17**	.09	.08	.00	-.09	-.10	.02	.08	-.13*	.04	-.07	.02	.02	-.10	.09	.01	-.09	--	
19	Cigarettes during pregnancy	.08	.06	.23**	.19**	.08	.05	.16**	-.12	-.20**	.11	-.16**	.01	-.01	.00	.04	.03	.23**	-.04	--
20	Alcohol during pregnancy	.07	.08	.25**	.32**	.15*	-.03	.20**	.09	-.03	.11	-.10	.02	.04	.00	-.01	.06	.06	.04	.37**

*P<0.5 **P<.01

c.2 Latent Variable Model Building

The first step in the analysis was to evaluate whether the three measures of stress (stressful life events, general discrimination and perceived stress) could be represented by a single, higher-order latent factor called maternal and paternal "stress." Separate stress latent factors were created for men and women. Based on the significant correlations between maternal and paternal measures of stress (Table III-2), I allowed correlations between the maternal and paternal residuals for each measure as well as correlations between maternal and paternal latent "stress" factors.

All path coefficients between the stress measures and the stress factor were statistically significant and greater than or equal to 0.40 (p's < .05) (Table III-6). The model of the higher-order latent stress factors exhibited good fit (X^2 =9.88, df=5, p=0.08; TLI=0.93; RMSEA=0.06 (0.00-0.12); PCLOSE=0.32).

Table III-6. Factor loadings onto women's and men's stress latent variables.

Women's Stress Latent	Estimate
General Discrimination	.91
Stressful Life Events	.52
Perceived Stress	.40
Men's Stress Latent	
General Discrimination	.68
Stressful Life Events	.51
Perceived Stress	.48

Factor structure invariance by gender and race/ethnicity

I tested the possibility that the way the stress measures load onto the stress latent factors could differ between men and women. The model fit did not differ significantly when constraining the loadings of each measure on to the latent stress constructs to be equal for men and women compared to a model when the measure loadings were allowed to vary by gender (X^2_{diff}=0.63, df=2, p=0.73).[159] Therefore, I concluded that the measures of stress loaded similarly for the maternal and paternal stress latent factors.

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I also tested the possibility that the factor structure differed by race/ethnicity. Because the "white" group was small, I compared the factor structures of blacks versus Hispanics. The model fit did not differ significantly when constraining the latent factors to be equal for black and Hispanic women (X^2_{diff}=3.84, df=6, p=0.70) nor black and Hispanic men (X^2_{diff}=6.35, df=6, p=0.39).[162] Therefore, I concluded that there was configural invariance by race/ethnicity.

c.3 Influence of the latent stress factors on birth weight and gestational age

Next, I created a model to examine the influence of the maternal and paternal latent stress factors on birth weight and gestational age (without covariates). The model exhibited good fit (X^2=14.23, df=13, p=.36; TLI=0.99; RMSEA=0.02 (0.00-0.07); PCLOSE=0.83). The path from paternal stress to gestational age was significant (B=0.29, P=.03) and the path from paternal stress to birth weight was marginally significant (B=71.30, P=.07). Both paths were positive (i.e. greater stress associated with better birth outcomes). The paths from maternal stress to gestational age (B=0.02, P=.90) and birth weight (B=-28.04, P=.43) were not significant, although the path to birth weight was in the expected negative direction.

A model adding in all maternal and paternal covariates except substance use (demographic characteristics, clinical risk factors, baby gender) also exhibited good fit (X^2=191.66, df=110, p<.001; TLI= 0.89; RMSEA= 0.05 (0.04-0.07); PCLOSE= 0.36). I did not include substance use covariates for all remaining analyses because, from a stress and coping framework,[163] substance use may be better described as a mediator between the effect of stress on birth outcomes rather than a confounder that I need to adjust for. The path from paternal stress to gestational age remained significant (B=0.31, P=.03) and the path from paternal stress to birth weight remained marginally significant (B=72.66, P=.06) and in the positive direction. The paths from maternal stress to gestational age (B=-0.001, P=.99) and birth weight (B=-37.01, P=.29) remained not significant, and both paths were in the expected negative direction.
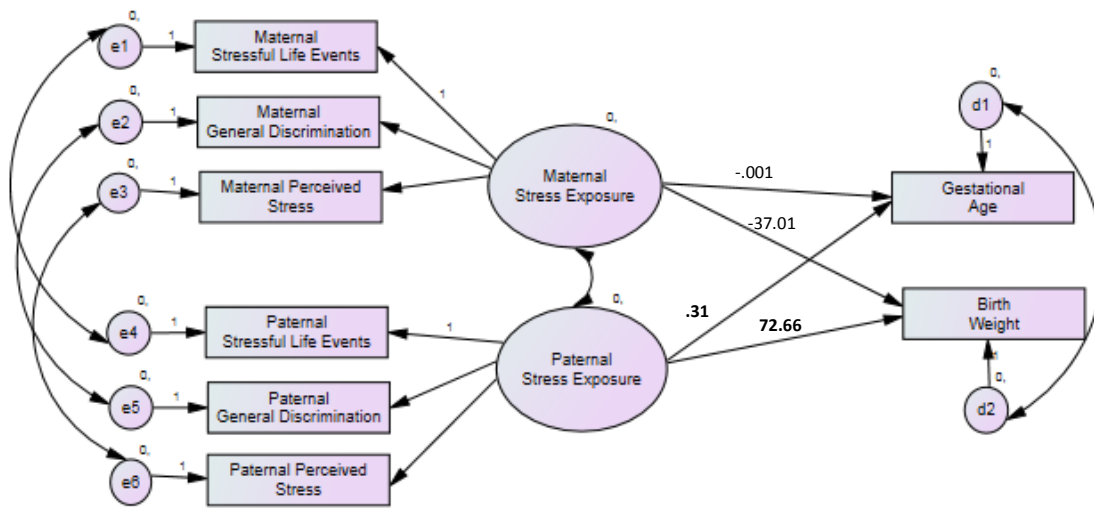
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Figure III-2. Structural equation model examining the impact of the latent maternal and paternal stress factors on birth weight and gestational age at delivery accounting for covariates (demographic characteristics, clinical risk factors, baby gender). Bold path coefficients displayed are statistically significant (P<.05) or marginally statistically significant (P=.06)

To quantify the impact of paternal stress on gestational age, I used regression imputation to create values for the latent variable of paternal stress.[162] Fathers with the highest level of stress (splitting the imputed paternal stress variable at the median) had babies that were born about 0.5 days later (M=39.52, SD=1.26) compared to babies born to fathers with low levels of stress (M=38.99, SD=1.17, t=-2.46, P=.02). Fathers with the highest level of stress also had babies that were 94.75 grams heavier (M=3,268.32, SD=480.04) compared to babies born to fathers with low levels of stress (M=3,173.57, SD=557.24, t=-1.50, P=.14), although the difference was not significant.

c.4 Mediation by depressive symptoms

Next, I examined mediation of the effect of paternal stress on birth outcomes by maternal and paternal depressive symptoms by entering maternal and paternal depressive symptom variables into the model that also accounted for all covariates (Figure III-3). The model fit was acceptable (X^2 =295.99, df=151, p<.001; TLI=0.85; RMSEA=0.06 (0.05-0.07); PCLOSE=0.06). To examine mediation by depressive symptoms, I first explored whether paternal stress was associated with his own and his partner's depressive symptoms. Greater paternal stress was only associated with his own depressive symptoms (B=6.33, P<.001). Second, I examined whether paternal depressive symptoms were associated with either birth outcome. Paternal depressive symptoms were not significantly associated with gestational age (B=-.01, P=.53) or birth weight (B=-3.94, P=.61).
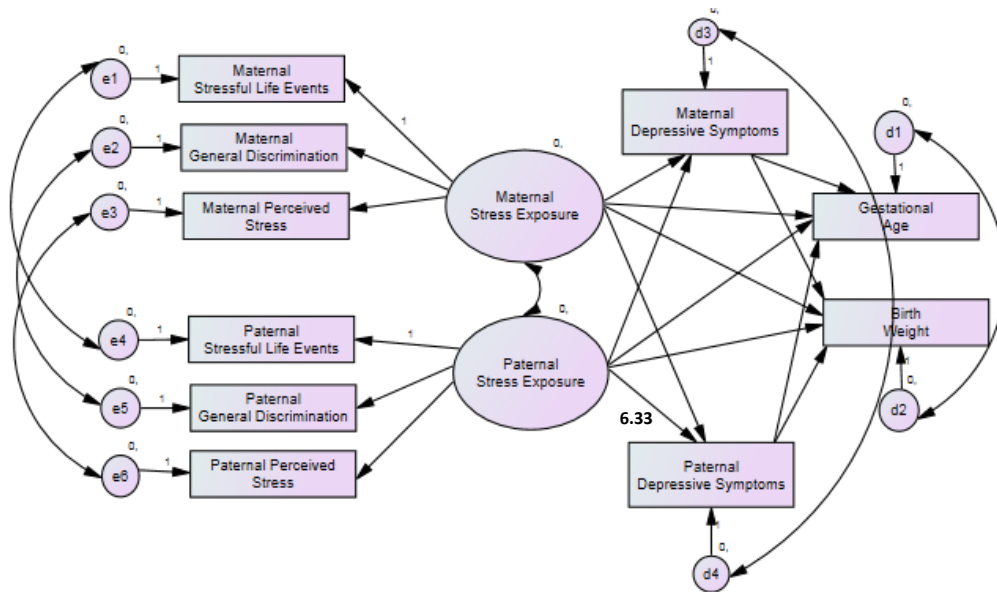

Figure III-3. Structural equation model examining mediation of the association between latent paternal stress factors on birth weight and gestational age at delivery by maternal and paternal depressive symptoms.

d. Discussion

Contrary to many published studies,[27,31–34,138] this analysis did not find a significant association between young expectant mother's stress during pregnancy and the gestational age at birth and birth weight of her baby. This analysis did find, however, that paternal stress during pregnancy was significantly *positively* associated with gestational age at birth—a finding that was contrary to my hypothesis that paternal stress would be negatively associated with birth outcomes. While the results were in the opposite of the expected direction, they suggest that paternal experiences during his partner's pregnancy are associated with his baby's birth outcomes and his experiences should not be ignored. In addition, the associations between paternal stress and the birth outcomes persisted after controlling for several important confounders, including clinical risk factors and demographic characteristics.

Lack of effect of maternal stress on birth outcomes

The lack of effect of women's stress on birth outcomes was contrary to much of the published evidence showing a significant negative effect of stress on birth outcomes.[27,31–34,138] the women in this study generally had low incomes ($13,590 household income) and were young. These young women were likely all under a high amount of stress as they grappled with potential relationship issues and financial challenges, while concurrently traversing the road to parenthood and adulthood. It is possible that all of the expectant women were under a high amount of stress and that there was not enough variability in the stress measure to identify an association with the birth outcomes.

In addition, the stress assessments used in this study did not include items that were specific to the stressors of pregnancy, which research has suggested may be a stronger predictor of birth outcomes among expectant mothers compared to general life event stress and perceived stress.[47] This may be an additional reason that I did not see an effect of maternal stress on birth outcomes. Pregnant women

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(and their partners) may experience life events and worries that are specific to being pregnant, such as concerns about financially supporting a baby or worries about the health and development of their baby. Not including these relevant stressors may have led to inaccurate estimates of the level of stress and its impact on birth outcomes in this study.[86]

Positive effect of men's stress on birth outcomes

The lack of effect of maternal stress on birth outcomes coupled with the *positive* effect of paternal stress on birth outcomes suggests that there may be an alternative model for how stresses processes influence birth outcomes. My original hypothesis was based on the traditional theory of human stress characterized mainly by the fight-or-flight response, in which a stressor activates the HPA and the immune/inflammation pathways within an expectant mother, which could affect fetal growth and initiate premature birth.[27,138] This theory assumes that the physiological and behavioral cascade of events that follows a stress exposure is the same for men and women. However, as the "tend and befriend" model of female stress response proposes, maternal responses to stress may not be best characterized solely by the fight-or-flight response.[164,165]

The "tend and befriend" model suggests that under conditions of stress, women are more likely than men to affiliate with others and seek social support.[164–166] In contrast, men are more likely to display behaviors that are fight-or-flight related under conditions of stress, such as aggressive behavior and substance use. These gender differences in behavioral stress responses are thought to be informed by the human attachment system, which is activated particularly in times of stress. Research has shown that women tend to display more attachment anxiety than men, and men tend to display more attachment avoidance.[167] As such, under conditions of stress, women in this study may have sought substantial support from the father of their baby. This maternal support seeking behavior may have benefitted the well-being of the expectant mother; however, this increased support seeking from the

expectant mother may have caused her male partner more stress. Thus, the young men in this study

may have provided more support to their expectant partner in this time of stress, which benefitted the

expectant mother's health and well-being, and ultimately the baby's well-being, but at the cost of their

own increased stress. In support of this hypothesis, I conducted a post-hoc analysis using imputed

values of the stress latent variables.[162] I found that women's stress was significantly correlated with her

own attachment anxiety ($r=.40$, $P<.001$),[g] and women's attachment anxiety was significantly correlated

with men's stress ($r=.15$, $P=.02$). Unfortunately, the original study did not include a measure of support

seeking.

Another potential explanation for this positive effect is that the women whose partners had the

most stress are less involved with their partner and more involved with their own family, who provide

compensating support for the expectant mother. A post-hoc analysis using imputed values of the

paternal stress latent variable[162] found that men with high levels of stress (median split) reported

greater depression, lower optimism, lower life satisfaction, and more smoking, alcohol use and

marijuana use. Perhaps the expectant women whose partners are highly stressed and exhibit these

unhealthy behaviors rely more on their own family for support, who compensate and ultimately help

support a healthy pregnancy. Post-hoc t-tests showed that women whose male partner had the highest

stress were significantly less likely to receive financial support from her male partner and marginally

more likely to receive financial support from her own parent. The men with the greatest stress also

reported more attachment avoidance and anxiety, which could have ultimately deterred a relationship

from being close. In fact, the men with the highest level of stress had lower intensity of feelings for their

partner.

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[g]Attachment anxiety was measured using the Experiences in Close Relationships Inventory (ECRI) by Brennan, Clark and Shaver (1998)[168]

Unfortunately, the original study that this data come from did not have a strong measure of "closeness" of the couple. A proxy for closeness of the couple may be the living arrangement of the couple—and specifically whether the expectant woman lives with her own mother or not. A post-hoc analysis found that the when the mother of the baby lived with her own mother (and not the baby's father), men's stress did not have a significant effect on gestational age (B=-.04, P=.85); however, when she lived with the baby's father (with her own mother or not), men's stress had a significant positive effect on gestational age (B=.38, P=.03) when controlling for all covariates except substance use.

Given that men's stress still had a positive effect on birth outcomes among the "closest" couples, the "tend and befriend" model is still consistent with these outcomes. When couples are closer, the men may be a stronger support system for the expectant mother, which could benefit her health and well-being and ultimately the health of the baby. However, this support of the expectant mother may come at the expense of higher stress for the baby's father. While social support for pregnant women and new mothers is considered important in our society, we generally pay little attention to expectant and new fathers. Interventions that support not only expectant and new fathers, but also the relationship between expectant and new parents may be important to the health and well-being of the whole family system.

Lack of mediation by depressive symptoms

Depressive symptoms did not mediate the effect of paternal stress on birth outcomes. In this study, there was no evidence of stress and strain crossover between members of the couple.[169] Maternal and paternal experiences of stress were not associated with their partner's depressive symptoms. This may be due to the fact that these couples are young, nearly all unmarried and 46.7% of the young mothers still live with their own mothers. Evidence has shown that the closeness of a couple may moderate the cross-over effect, with closer couples experiencing more cross-over of the effects of

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stress from one member to the other.[73] Many of the couples in this study may not have had close enough relationships for paternal stress to cross over and affect maternal feelings of stress and well-being. In a post-hoc moderated mediation analysis,[162] however, the effect of men's and women's stress on their partner's depressive symptoms still did not differ based on whether she lived with the father of her baby or with her mother (and not the baby's father) ($Z=-.71$, $P>.05_{\text{men's effect on women}}$; $Z=-.38$, $P>.05_{\text{women's effect on men}}$) when controlling for all covariates except substance use.

Concluding remarks and future research directions

Future studies would be strengthened by the inclusion of stress appraisals and perceptions. What is stressful for one person may not be stressful for another, and therefore the likelihood of reporting a stressful event may be affected by an individual's appraisal of the stressor.[90] Measures of stress appraisals and perceptions could ascertain the individual's perception and evaluation of potential harm posed by a specific external demand (i.e. stressor) and their ability to cope with the demand.[170] The inclusion of biological indicators of stress responses may also help elucidate this gap between whether a stressor actually has a physiological effect on the expectant mother that could ultimately affect the health and development of the fetus.[35]

Despite the fact that the findings from this investigation may leave us with more questions than answers about paternal effects on birth outcomes, even including father's experiences and feelings within birth outcome research is a step in the right direction as there has been virtually no investigation in this arena. The findings from this study suggest that there *is* a relationship between birth outcomes and men's experiences during pregnancy; however, the lack of consistency of the findings with accepted theory on how stress affects health indicates that more research is necessary. This is the first analysis to explore the effect of *paternal* stress on birth outcomes, and the pathways through which he has an

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effect. This analysis also assessed direct report of stress exposures and responses from the fathers, avoiding measurement error associated with using maternal reports of paternal experiences.

The analytical techniques used in this research also strengthen the analyses. The analysis accounted for the correlated nature of maternal and paternal reports, while maintaining the strength of the total sample size (i.e. without conducting the analyses separately by gender). In addition, structural equation modeling allowed for the simultaneous assessment of multiple hypotheses involving complex pathways, while parceling out measurement error.

This is the first study in the literature to date that explores the role of expectant father's experiences of stress during his partner's pregnancy on his child's birth outcomes using direct report from the fathers and strong analytical techniques. The study demonstrates that paternal experiences of stress during his partner's pregnancy are significantly associated with birth outcomes, but not in the direction that is consistent with conventional theory of how stress is related to one's own and one's partner's health and well-being. This study offers a unique perspective building on the "tend and befriend" model to explain how greater paternal stress during pregnancy may be positively associated with his baby's birth outcomes. Future studies that further explore alternative models for how paternal experiences and well-being during pregnancy affect his baby's birth outcomes are warranted.

Chapter IV.   Stress and Behavioral Risk among Young Expectant Couples

a. Introduction

Learning to cope with psychosocial stress is a fundamental component of adolescent development. Decades of research has shown us that exposure to stressors and the ways in which adolescents manage their emotions, thoughts and behaviors influence their mental and physical health.[171,172] Much research has helped elucidate the types of stress adolescents experience and the ways in which they cope, which can include unhealthy behaviors such as substance use (e.g.[143,173–179]). There has been little investigation, however, into the basic nature of stress and coping among adolescents who are expecting a baby. This population is important because their responses to stress (take for example, smoking) carry implications for the unborn child. In addition, coping styles (whether healthy or unhealthy) are sensitive to situational factors and developmental changes, such as pregnancy. Thus, coping behaviors exhibited during this sensitive period of fetal development may affect the child's health later in life. Pregnancy may further provide a window of opportunity for intervention—expectant parents are often motivated to change or establish healthy behaviors for the good of their child[180]—and pregnancy may be an opportune time to help couples learn to better manage stress in an effort to support their health and their relationship as parents. We need better information, however, about the nature of the stressors that *expectant* adolescents experience and their responses in order to inform effective interventions.

The experience of becoming a parent is a major life transition that may elicit many new stressors not only for young women, but also for the fathers of their baby. Despite the fact that pregnant adolescent females in the United States are usually unmarried,[39] many still have a relationship with the baby's father during pregnancy[65] and therefore, these young men are also experiencing the major life transition of becoming a parent. Substantial research has shown us that social support can improve coping and buffer the effect of stress on well-being [e.g. 69,181] and that romantic relationships can be a significant source of this much needed social support. Studies have also shown that a romantic

partner's experiences of stress can cross over and affect one's own well-being.[72,169] Despite the interpersonal nature of stress and coping, and the fact that romantic relationships are present and important among pregnant adolescents, few studies of adolescent experiences of stress during pregnancy include the direct report of experiences and behavioral responses of the baby's father.

This paper uses stress and coping theory, and stress and strain crossover theory to predict that expectant adolescents' and young adults' own experiences of stress are associated with their own *and their romantic partner's* health behaviors.

Stress and coping theory

Extensive research has demonstrated a consistent association between stress and health behaviors.[e.g.46,140,178,182,183] This research is based on the hypothesis that people use health behaviors to cope with the distress that they experience. Individuals experience stress when demands exceed the resources the individual has to deal with the demands.[140] When individuals appraise a stressor as harmful, threatening or challenging, they use coping strategies to regulate the stress they experience.[171,184] Some of the coping mechanisms are adaptive and promote health and well-being, such as *active coping* (addressing or altering a stressor through active problem solving,) and *support seeking* (obtaining emotional support from a social network). Other coping mechanisms may lead to behaviors and emotions that can lead to poor health and well-being, such as *disengagement* (avoiding, withdrawing from or denying a stressor) and *distraction* (doing things that take the mind off the stressor).[171,184,185] Negative health behaviors, including substance use and venting anger (which could lead to conduct problems), can serve as a way for adolescents to withdraw from or keep their mind off a stressor, reduce emotional distress or release negative feelings.[163]

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Adolescents and young adults may also use negative health behaviors to cope with new and challenging stressors because they may not have developed healthier coping strategies. Adolescent's problem solving abilities, regulation of emotions, empathy and perspective-taking ability are still evolving during this developmental period.[186] Thus, adolescents may use negative health behaviors as coping mechanisms because they have not learned to employ other more adaptive coping strategies, such as identifying and actively pursuing alternative solutions.

Additionally, there is evidence that men and women have different reactions to stress. Studies have found that men are more likely to exhibit externalizing coping behaviors, such as substance use, in response to stress, while women are more likely to exhibit internalizing behaviors or affect (e.g. depressive symptoms) in response to stress.[187,188] The "tend and befriend" model of the stress response proposes that under conditions of stress, men are more likely than women to display "fight-or-flight" related behaviors, such as substance use and aggressive behaviors. This model also suggests that stress is more likely to cause women to affiliate with others and seek social support.[164–166]

Sources of stress and evidence of the impact on adolescent and young adult health behaviors

Adolescents and young adults experience stressors that emanate from various life domains, including close relationships (e.g. a fight with a romantic partner) and general personal hardships (e.g. having something important stolen).[172,189] For adolescents and young adults who are racial and/or ethnic minorities and are from a low socioeconomic status (SES), daily stressors often extend beyond these typical developmental challenges. This population is disproportionately affected by other more severe and chronic stressors, such as neighborhood problems, racism and discrimination.[38] Coping strategies that are typically viewed as the most adaptive and produce the most positive outcomes, may not be realistic or even safe for adolescents within these circumstances. For example, one study found that active coping in response to exposure to violence was associated with increased aggression among

impoverished urban adolescents.[190] In the face of chronic and severe stressors that adolescents have little control over, such as discrimination and neighborhood problems, avoidant coping strategies (such as substance use as a method of disengagement and distraction) that afford them some transcendence from the day to day burden of stress may actually be an adaptive response and even have some benefits.[38,190]

Substantial evidence, discussed below, has demonstrated a link between experiences of stress in each of these domains and negative health behaviors among adolescents and young adults. Neighborhood problems disproportionately affect minority and low-income communities and have been consistently linked to negative health behaviors among adolescents. Neighborhood problems, such as vandalism, rundown buildings, drugs and fights in the streets, become chronic stressors that may elicit negative coping mechanisms among adolescents living in the neighborhood.[143,173] For example, Kowaleski-Jones (2000) reported that perceived neighborhood problems were related to deviant behavior.[175] Among a sample of adolescents in Los Angeles, the perception of their neighborhood as dangerous was related to more oppositional defiant disorder and conduct disorder.[176]

Experiences of discrimination have also been linked to negative health behaviors among adolescents. A nationally-representative survey of African American adolescents found that 87% experienced at least one source of discrimination in the previous year.[191] Several studies among adolescents and young adults show that experiences of discrimination predict greater smoking[177] and other substance use.[182,192]

Discrete life stressors or personal hardships, referred to as stressful life events, are also common among adolescents and young adults. These stressful life events, such as losing a job or having something stolen, have been consistently associated with smoking,[178,182,183] and alcohol use[182] among adolescents and young adults. Further, among adolescents, experiencing more stressful life events has also been associated with greater conduct problems.[193]

Other discrete stressors stemming from important social relationships (e.g. parents and romantic partners) can have a significant influence on adolescent and young adult behavior. During adolescence and young adulthood, social relationships within and outside of the family, including romantic relationships, are extremely important.[97] Acute social-relationship stressors, such as family conflict[194] and romantic relationship dissolution[179] have been related to more substance use among adolescents and young adults.

Stress and the effects on health behavior among pregnant adolescents and young adults

Another important factor impacting the stress experienced by adolescents and young adults is their experience of pregnancy. Ethnic and/or racial minority adolescents and young adults experience a disproportionately high pregnancy rate.[195] Pregnancy can be a stressor for an expectant parent of any age or gender.[148,196] Pregnancy involves significant emotional and physical demands. It is also a major life transition that elicits many stressors, such as concerns over finances, health, and relationships with a romantic partner and family. For adolescents and young adults, the transition to parenthood may further overload coping resources and be exceptionally stressful.[149,197] This stress may lead to engaging in poor health behaviors, even among expectant mothers who intended to abstain from substance use during pregnancy. Many studies have demonstrated that maternal stress during pregnancy is associated with poor maternal health behaviors (e.g. smoking and substance use),[46,139] although these studies have been conducted among adult women.

There is very little research exploring experiences of stress and health behaviors among expectant fathers (of any age), despite the fact that a partner's pregnancy is also a major life transition for expectant fathers who may also have concerns over many issues, including finances and relationships.   A young man's experiences during pregnancy may impact his own health and behavior, as well as his pregnant partner's behavior, carrying implications for the health and development of their

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child. Substantial evidence has shown that social relationships have important influences on our health and well-being.[62] A majority of expectant female adolescents and young adults are involved with the baby's father during pregnancy,[65] and therefore he likely has an important influence on her during her pregnancy.[98] Despite this fact, the paternal experience during pregnancy has largely been ignored in the literature, and when it is acknowledged, it is usually reported by the expectant mother, introducing potential measurement error.

Stress and strain crossover: theory and evidence

While substantial evidence demonstrates that experiences of stress are predictive of one's own health behaviors, some evidence suggests that experiences of stress can also crossover and affect the well-being of one's romantic partner.[72,169,198] For example, a woman's partner's experiences of stress have been associated with increases in her own depressive symptoms.[72] It is thought that stress can be transferred from one person to the next through the socio-emotional process of empathetic distress, or the "emotional involvement in the problems and distressed feelings of a relationship partner, to the point of taking on the partner's emotional distress and experiencing it as one's own."[199] While empathy for others is considered a developmentally adaptive competency[200] and is fundamental to the development of close relationships,[201] evidence has shown that there can be substantial emotional "costs of caring"[202] that can be mediated by this process of empathetic distress.[199]

This crossover of stress has been documented among young adolescent friend pairs, with young women reporting more empathetic distress than young men.[199] Given evidence that men and women report different patterns in internalizing and externalizing responses to stress,[187,188] it is possible that young men may report less empathetic distress, but more externalizing coping behaviors (e.g. substance use) as a result of his partner's stressful experiences.

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Current study

Many studies have shown that an adolescent's experiences of stress have a negative influence on their own health behaviors (e.g.[143,173–179]) and at least one study has shown that adolescents' experiences of stress can influence a close friend's emotional distress.[199] There is also a substantial literature focused on the transmission of job-related stress among husbands and wives.[72]

Very little attention has been paid to the consequences of experiences of stress on romantic partners—someone with whom a pregnant adolescent or young adult has an important relationship and interacts frequently. No research to our knowledge has explored paternal experiences of stress during his partner's pregnancy and the effects on his own and his pregnant partner's health behaviors. Further, no studies have explored whether experiences of stress can crossover and affect a romantic partner's health behaviors among adolescents and young adults who are expecting a baby.

The current study aims to fill these gaps in the literature by examining how both personal and partner experiences of stress are associated with poor health behaviors during pregnancy among a sample of expectant adolescent and young adult couples who are largely racial and/or ethnic minorities and have a low socioeconomic status. First, I describe expectant parents' experiences of stress during pregnancy across several domains (e.g. personal hardship, close relationship stressors, neighborhood problems and discrimination). Second, drawing from stress and coping theory, I describe the association of these experiences with negative health behaviors and mental health (substance use, conduct problems and depressive symptoms). Third, I draw upon stress and strain crossover theory to explore partner effects—the association between a *partner's* experiences of stress with one's own poor health behaviors and mental health.

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b. Methods

b.1 Data Source

The current study is a secondary cross-sectional data analysis of baseline data collected between 2007 to 2011 from 296 expectant young couples (females ages 14–21 years and their male partners ages 14+ years) enrolled in a longitudinal study of relationships and health during the transition to parenthood. Detailed study procedures are published elsewhere[203] and within the previous chapter. In short, young women and men in a romantic relationship and expecting a baby were recruited from four urban university affiliated hospital-based clinics in southern Connecticut (CT) (Yale University Women's Center and ultrasound clinic, Bridgeport Hospital OB/GYN clinic, New London OB/GYN clinic, and Hospital of St. Raphael OB/GYN clinic). The couples completed separate audio computer-assisted self-interviews (A-CASI), which allows participants with low literacy to complete the survey [204] and elicits more accurate and valid responses to sensitive questions.[205,206] Of the 413 eligible couples screened, 72.2% enrolled. Compared to those who refused to participate, participants were on average two weeks further along in pregnancy at screening ($P < 0.03$). Participants versus those who refused participation did not vary by any other pre-screened demographic characteristic (all $P > 0.05$).

A research assistant obtained informed consent from the each member of the couple (individually) at the baseline survey. Participation was voluntary, confidential, and did not influence the provision of health care or social services. All procedures were approved by the Yale University Human Investigation Committee and by Institutional Review Boards at study clinics. IRB approval to use the de-identified PARTNRS data was also obtained from the CUNY Graduate Center.

b.2 Measures

Stressors

Stressful life events related to *close relationships* and *personal hardship* were evaluated by adapting the Life Events Scale.[151] Respondents indicated whether they had experienced 11 stressful life events in the previous 6 months. Four stressful life events, including broke off a steady relationship, a relative suffered a serious illness, injury or assault, a family member or close friend died and had a serious problem with a friend, neighbor, or relative, were grouped and summed as *events related to close relationships*. Seven stressful life events, including having money problems, being unemployed, moving, having something lost or stolen, problems at work or school, problems with the police, and suffered a serious illness, injury or assault, were grouped and summed as *events related to personal hardship*. Higher scores on this measure indicate the respondent experienced more stressful life events.

Respondents' perception of *neighborhood problems* was assessed using a 15-item adapted version of the Perceived Neighborhood Problems Scale.[207] Respondents indicated how much various neighborhood problems were an issue in their neighborhood, on a 3-point scale ranging from 1="not a problem" to 3="serious problem." Sample items from the original scale include "smells and fumes," "assault and muggings," and "vandalism." Two additional items were added to the original 13-item scale: "feeling unsafe after dark" and "drugs." Responses to items were summed to form a total *neighborhood problems* scale ranging from 15 to 45 (α = .95).

Perceived *general discrimination* was assessed using a 20-item adapted version of the Daily Life Experiences Scale, a subscale of the Racism and Life Experiences Scales.[208] Items concerned how often respondents experienced discriminatory treatment, such as not being given service in a store or restaurant, or being stared at by strangers. Responses were indicated on a 6-point scale ranging from 0="Never" to 5="Once a Week or More." A mean score was calculated from the 20 items to form the *general discrimination* score (α = .93).

Health Behavioral Risk

Smoking, drinking, marijuana use and hard drug use were measured using an adapted, 7-item version of the Recreational Drug Use Scale.[153] Frequency of use during the past three months for each substance (alcohol, cigarettes, marijuana, crack, heroin, methamphetamines, and "other hard drugs") was assessed using a 5-point Likert scale, ranging from 0 = "Never" to 4 = "Every Day." The adapted version included the item "other hard drugs" in lieu of the individual items in the original scale of barbituates, ectasy, gammahydroxybutyrate (GHB), hallucinogens and inhalant nitrates. We summed the report of the use of crack, heroin, methamphetamines, and "other hard drugs," to form a total *hard drug use* score (range 0 to 16) due to the low frequencies of these individual items.

Conduct problems were assessed by means of an adapted, 7-item version of the DSM Conduct Problems Scale.[209] Respondents reported the frequency of various conduct problems in the previous 6 months on a 4-point scale ranging from 1= "Not at All" to 4="5 or more times." Sample items included "skipped school or work," "got in a fight," and "stole something." Items were summed to form a total conduct problems score ranging from 7 to 28, with higher scores indicating more conduct problems.

Mental Health

Depressive symptoms over the past week were measured using 15 of the 20 items in the Center of Epidemiological Studies-Depression Scale (CES-D).[91] Participants responded on a 4-item scale ranging from 0="Less than 1 day" to 3="5-7days". Items included "during the past week I had crying spells" and "during the past week I felt depressed."

b.3 Statistical Analysis

I produced descriptive statistics using IBM SPSS Statistics V22 (IBM Corporation, Armonk, NY) of the demographic characteristics, stressors and behavioral risk outcomes among the sample population. Two men were missing data for stressful life events and therefore I excluded two couples from the analysis resulting in a final sample of 294 couples (n = 588). I used paired t-tests and McNemar's tests to compare the demographic characteristics, stressors and behavioral risk outcomes variables between paired men and women.

I used multilevel modeling to explore the relationship between experiences of stressors and the behavioral risk outcomes during pregnancy: smoking, drinking, marijuana use, hard drug use, conduct problems and depressive symptoms. Specifically, I used the Actor-Partner Interdependence Model (APIM), to account for the correlated nature of the data. This model allowed me to assess the influence of both the respondent (actor effect) and their partner (partner effect). An actor effect indicates whether a respondent's score on a predictor variable is associated with their own outcome (e.g. woman's experiences of stressors relates to her own smoking). A partner effect indicates whether a respondent's partner's score on the predictor variable is associated with the respondent's outcome (e.g., male partner's experiences of stressors influences his female partner's smoking). The APIM uses a single analysis to incorporate responses from both members of a couple and treats the members of a couple as nested scores within the same group.[210] A detailed description of APIM analyses using multilevel modeling programs by Kenny, Kashy, & Cook (2006) served as the guide for our analysis plan. Analyses involving hard drug use were restricted to the male data because no females reported hard drug use. To assess whether gender moderated the influence of stressors on all other health behavior outcomes, gender by stressor interaction terms were tested.

All models controlled for maternal and paternal age, education, income and race/ethnicity. In addition, analyses controlled for role occupancy (defined in this analysis as whether they worked, went

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to school or had other children) because people who have greater role occupancy are likely exposed to more stressors.[81]

c. Results

c.1 Descriptive Statistics

Demographic characteristics of the participants are displayed in Table IV-1. The young men were generally older, had more personal income, were more likely to be employed, and were less likely to be in school compared to their female partners.

Table IV-1 also shows that young men and women reported similar amounts of stressful life events related to close relationships and stressful life events related to personal hardship (both P>.05). Young men reported more neighborhood problems (22.4% vs. 24.4%, P<.001) and more general discrimination (M=0.9 vs. M=1.0 out of 5, P=.02) compared to young women. Table IV-2 shows that money problems were the most common life event stressor in the past six months among both men and women. About one third of the respondents also reported moving within the past six months.

Table IV-1. Demographic characteristics, stressors and outcomes from baseline survey.

	Women		Men		McNemar's Test
	%	(N)	%	(N)	P
Demographics					
Employed	28.40	(84)	60.70	(179)	<0.001
In School	39.50	(117)	26.90	(79)	<.001
First Child	21.00	(62)	24.30	(71)	NS
Race/Ethnicity					
Black	39.50	(117)	48.60	(144)	<.001
Hispanic	39.50	(117)	36.50	(108)	
White	16.90	(50)	10.50	(31)	
Other	4.10	(12)	4.40	(13)	
	Mean	**(SD)**	**Mean**	**(SD)**	**Paired T-Test**
Age	18.71	(1.63)	21.33	(4.06)	<.001
Years School	11.75	(1.82)	11.84	(1.89)	NS
Personal Income ($)	5846	(7458)	10927	(11878)	<.001
Stressors					
Personal Hardship Stressors (out of 7)	1.46	(1.34)	1.66	(1.63)	0.07
Close Relationship Stressors (out of 4)	0.63	(0.94)	0.66	(0.93)	NS
Neighborhood Problems (on scale from 15-25)	22.41	(7.54)	24.39	(8.35)	<0.001
General Discrimination (on scale from 0 to 5)	0.85	(0.81)	1.02	(1.01)	0.02
Outcomes					
Substance Use Past 3 months (0=never to 4=every day)					
Smoking	0.36	(0.95)	1.13	(1.47)	<.001
Drinking	0.05	(0.24)	0.85	(0.98)	<.001
Marijuana Use	0.07	(0.38)	0.81	(1.28)	<.001
Hard Drug Use	--	--	0.25	(1.25)	--
Conduct Problems (on a scale 7-28)	24.03	(3.50)	24.77	(3.56)	.005
Depressive Symptoms (on a scale from 0 to 45)	10.53	(7.38)	8.88	(6.62)	.002

Table IV-2. Frequencies of individual life event stressors in past 6 months among men and women reported at baseline.

	Women	Men	McNemar's Test
	%	%	P
Personal Hardship Stressors			
Money Problems	44.6	45.2	.92
Being Unemployed	26.0	33.3	.04
Moving	35.8	29.3	.07
Having something lost or stolen	16.6	22.4	.09
Problems at work or school	13.2	12.2	.80
Problems with police	4.7	13.9	<.001
Suffered illness, injury, assault	4.7	9.2	.05
Close Relationship Stressors			
Broke off steady relationship[h]	26.0	7.1	.06
Relative suffered illness, injury assault	17.6	16.7	.81
Family member or close friend died	24.0	26.2	.49
Serious problem with friend, neighbor, relative	17.2	16.3	.82

[h] This item refers to any relationship, including the current relationship. Each individual provided his/her own response. Discrepancy in the couples percentages here indicate that participants may have had other relationships in the previous six months and/or may not perceive a "break-up" the same way.

c.2 Multilevel Regression Analyses

Table IV-3 shows the results of the multilevel regression models examining the association between the stressors and the outcomes. Each outcome was tested in separate models controlling for all demographic characteristics. The results below describe the results of the gender interaction analyses. Because many of the outcome variables did not have a normal distribution, I also ran multilevel linear regression models with natural log transformed outcomes. The tables are shown in Appendix III-3. The results were substantively the same so only the results from the linear regression models are shown in the main text.

Personal Hardship Stressors and Health Behaviors and Mental Health

Among the total sample, in adjusted models greater frequency of personal hardship stressors predicted more smoking (B=.08, SE=.04, t=2.09, p=.04), marijuana use (B=.04, SE=.02, t=1.90, p=.06), conduct problems (B=.45, SE=.11, t=4.26, p<.001) and depressive symptoms (B=0.41, SE=0.22, t=1.87, p=.06) (Table IV-3). Gender interacted with personal hardship stressors when predicting marijuana use (t=1.96, P=.05) and alcohol use (t=1.97, P=.05). Greater frequency of personal hardship stressors was associated with more marijuana use (B=.14, SE=.05, t=2.76, P=.006) and alcohol use (B=.10, SE=.04, t=2.817, P=.005) among young men only. Gender also interacted with *partner's* personal hardship stressors when predicting marijuana use (t=2.66, P=.008) and depressive symptoms (t=-2.11, P=.04). Greater frequency of *partner's* personal hardship stressors was associated with less marijuana use (B=-.13, SE=.05, t=-2.48, P=.014) and more depressive symptoms (B=0.77, SE=0.28, t=-2.79, P=.006) among young men only.

Close Relationship Stressors and Health Behaviors

Gender interacted with close relationship stressors when predicting smoking (t=2.096, p=.037) and marijuana use (t=2.92, p=.004). Greater frequency of close relationship stressors predicted more

smoking (B=.22, SE=.09, t=2.44, p=.015), marijuana use (B=.30, SE=.08, t=3.58, p=<.001) and hard drug use (B=.34, SE=.09, t=3.81, p<.001) among young men only. Gender also interacted with *partner's* close relationship stressors when predicting conduct problems (t=2.1, P=.04). Greater frequency of *partner's* close relationship stressors related to more conduct problems among young women only (B=.58, SE=.20, t=2.88, p=.004).

Neighborhood Problems and Health Behaviors

Among the total sample, in adjusted models greater frequency of neighborhood problems predicted more smoking (B=.02, SE=.01, t=2.94, P=.001) and depressive symptoms (B=.07, SE=.04, t=2.00, P=.047) . Gender interacted with neighborhood problems when predicting smoking (t=2.09, P=.037), alcohol use (t=2.63, P=.009), marijuana use (t=3.30, P=.001) and neighborhood problems (t=2.42, P=0.16). Greater frequency of neighborhood problems predicted more smoking (B=.04, SE=.01, t=3.89, P<.001), alcohol use (B=.02, SE=.007, t=3.035, P=.003) and marijuana use (B=.03, SE=.008, t=3.77, P<.001) among young men only. Greater frequency of neighborhood problems predicted more depressive symptoms (B=.12, SE=.04, t=2.71, P=.007) among young women only. Gender interacted with *partner's* neighborhood problems when predicting smoking (t=-2.07, P=.039). Greater p*artner's* neighborhood problems related to less smoking among young men only (B=-.02, SE=.01, t=-2.02, P=.04).

General Discrimination and Health Behaviors

Among the total sample, in adjusted models greater frequency of general discrimination predicted more conduct problems (B=1.17, SE=.16, t=7.35, p<.001) and more depressive symptoms (B=1.41, SE=.33, t=4.27, P<.001). Gender interacted with general discrimination when predicting alcohol use (t=2.63, P=.009) and depressive symptoms (t=-2.54, P=.01). Greater frequency of general discrimination predicted more alcohol use (B=.15, SE=.06, t=2.652, P=.008) and hard drug use (B=.22,

SE=.08, t=2.82, P=.01) among young men only. Greater frequency of general discrimination predicted

more depressive symptoms among both young men (B=2.68, SE=.56, t=4.81, P<.001) and young women

(B=.86, SE=.38, t=2.29, P=.02) although the effect was much stronger for men than women.

Table IV-3. Multi-level linear regression models examining relationship between stressors (own and partner's) and behavioral risk and depressive symptoms. All models control for age, education, income, race/ethnicity, parity and employment status.

	Smoking			Drinking			Marijuana Use			Hard Drug Use[a]			Conduct Problems			Depressive Symptoms		
	B	SE	t	B	SE	t	B	SE	t	B	SE	t	B	SE	t	B	SE	t
Personal Hardship Stressors																		
Actor	**0.08***	**0.04**	**2.09**	0.02	0.01	1.37	**0.04‡**	**0.02**	**1.90**	-0.02	0.06	-0.34	**0.45***	**0.11**	**4.26**	**0.45***	**0.22**	**2.01**
Partner	-0.04	0.04	-1.11	-0.02	0.01	-1.58	-0.02	0.02	-0.98	-0.02	0.07	-0.24	0.09	0.10	0.84	0.34	0.23	1.52
Close Relationship Stressors																		
Actor	0.00	0.05	-0.01	0.02	0.02	1.27	0.04	0.03	1.75	**0.34***	**0.09**	**3.81**	0.26	0.15	1.68	0.49	0.33	1.49
Partner	-0.01	0.06	-0.12	0.00	0.02	-0.24	0.02	0.03	0.94	-0.08	0.09	-0.96	0.23	0.15	1.48	0.50	0.33	1.54
Neighborhood Problems																		
Actor	**0.02***	**0.01**	**2.94**	0.00	0.00	0.27	0.01	0.00	1.63	0.00	0.01	-0.20	0.02	0.02	1.24	**0.07***	**0.04**	**2.00**
Partner	0.00	0.01	-0.34	0.00	0.00	-1.50	0.00	0.00	-0.92	0.00	0.01	-0.34	-0.01	0.02	-0.37	-0.04	0.04	-1.06
General Discrimination																		
Actor	-0.01	0.06	-0.09	0.02	0.02	0.94	0.03	0.03	0.91	**0.22****	**0.08**	**2.82**	**1.17***	**0.16**	**7.35**	**1.39***	**0.33**	**4.21**
Partner	0.06	0.05	1.17	-0.01	0.02	-0.83	-0.01	0.02	-0.60	0.07	0.11	0.66	0.10	0.16	0.61	-0.16	0.35	-0.47

* P<.05 ** P≤ 0.01 *** P≤ 0.001 ‡ P=.06

[a]Only reported for men

Table IV-4 provides a description of the significant associations between one's own and one's

partner's experiences of stressors and behavioral risk among the young men and women within couples.

Table IV-4. Descriptive table of significant associations between stressors and behavioral risk among couples.[a]

Stressor		Women	Men
↑ **Personal Hardship Stressors**	Own	↑ conduct problems ↑ smoking ↑ depressive symptoms	↑ conduct problems ↑ smoking ↑ drinking ↑ marijuana use ↑ depressive symptoms
	Partner's		↓ marijuana use ↑ depressive symptoms
↑ **Close Relationship Stressors**	Own		↑ smoking ↑ marijuana use ↑ hard drug use
	Partner's	↑ conduct problems	
↑ **Neighborhood problems**	Own	↑ depressive symptoms	↑ smoking ↑ drinking ↑ marijuana use
	Partner's		↓ smoking
↑ **General Discrimination**	Own	↑ conduct problems ↑ depressive symptoms	↑ conduct problems ↑ drinking ↑ hard drug use ↑ depressive symptoms
	Partner's		

[a] Examples of how to read this table: Greater frequency of partner's personal hardship stressors associated with greater depressive symptoms among men. Greater frequency of one's own experiences of discrimination associated with own depressive symptoms among men and women.

d. Discussion

The findings of this study demonstrate that one's own experiences of several types of stressors are related to substance use, conduct problems and depressive symptoms among both expectant women and men. Negative health behaviors common during adolescence and young adulthood predict future patterns of behavior and health outcomes into adulthood. These behaviors are also important due to their capacity to also affect the health of their baby.

The evidence from this study also concurs with the stress and strain crossover theory, in which stressful experiences in one's own life, cross over and affect the health and well-being of a close partner.[72] While several studies have demonstrated that maternal stress is associated with poor maternal health behaviors during pregnancy,[46,139] this study is the first to show that *paternal* experiences of stress are predictive of maternal conduct problems. Previous studies examining the patterns and predictors of maternal health behaviors have largely neglected paternal influences, despite increasing evidence that social relationships influence health behaviors.[211]

Personal experiences of stress and one's own health behaviors

This study identified several domains of stress that were associated with behaviors among young men becoming fathers. Notably, greater personal experiences of all sources of stress (relationship stressors, personal hardship stressors, neighborhood problems and discrimination) were associated with more substance use among the young men in this study. While most research has focused on predictors of maternal health behaviors, understanding the predictors of *paternal* health behaviors has important implications not only for his health, but for his pregnant partner's health as well. Men's negative health behaviors, such as smoking, can directly influence maternal health (e.g. by increasing her exposure to second hand smoke) and men's health behaviors can influence his partner's health behaviors. For example, studies have shown that women are less like to quit smoking during

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pregnancy if her partner smokes.[212] Programs and interventions that aim to reduce substance use among young expectant mothers may be more effective if the substance use of *both* parents is addressed.

Among the young women in this study, however, significant associations between stress and substance use were sparse. I did find, however, that experiences of personal hardship stressors were associated with more smoking among women. The lack of consistent associations between maternal stress and substance use in this study may be an artifact of the low prevalence of the report of substance use among the women. These results, however, may show that the stressors that affect paternal and maternal substance use during pregnancy may be different. Previous research has shown that different types of stressors predicted smoking among adolescent girls compared to boys.[213] Previous research has shown that young men and women may use different coping mechanisms to deal with stress[166,214] and the evidence from this study may suggest that young expectant men use substance use as a coping strategy for stress more often than young expectant women.

Partner's experiences of stress and one's own health behaviors

A majority of previous evidence supporting the stress and strain crossover theory has found negative effects of stress and strain on a partner's well-being.[169] Contrary to this evidence and our hypothesis, all of the significant effects of the young men's partner's stress (i.e. the association between women's stress with her male partner's behaviors) were associated with *less risk* behavior and *more protective* behavior. Young women's personal hardship stressors were significantly associated with less marijuana use among her male partner, and more women's neighborhood problems were significantly associated with less smoking among her male partner. This study, however, found that young men's depressive symptoms were directly associated with his partner's personal hardship stressors. This

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evidence is consistent with the theory of empathetic distress in which a person takes on the experiences of stress and distressed emotions of his/her partner and experiences them as one's own."[199]

These findings suggest that not all experiences of stress necessarily translate into negative effects on a partner. Popular culture may portray young expectant women's partners only as sources of stress or complication; however, the findings from this study suggest that young men who see that their partner is under significant stress, may improve their health behaviors for their partner's benefit and may empathize with their partner's troubles to the point that they take on the distressed emotions as their own. For all of the negative portrayal of young fathers, they can be an important source of support[215] and fathers may have a meaningful influence on the health behaviors of their pregnant partners.[216]

Strengths, Limitations and Future Research Directions

This secondary data analysis has several limitations. This study was cross-sectional and therefore experiences of stress and behavioral risk were assessed at the same point in time limiting our ability to infer causation. The timeframes referenced by each question, however, make the direction of the hypothesized association plausible. The risk behavior items referred only to behaviors in the previous 3 months. Both personal hardship and close relationship stressors referred to experiences within the past six months. While neighborhood problems and general discrimination were more general questions referring to their daily life, these constructs are likely consistent over time.

Also, pregnant women reported few negative health behaviors in this study during pregnancy. Therefore, the association between experiences of stress and behavioral risk among the women in this sample may be spurious; regardless, I was able to identify a few significant relationships between stress and health behaviors among the women.

Despite these limitations, this study is one of the few that includes a direct report from men of their experiences of stress during their partner's pregnancy and its relationship to risk behavior. In addition, this study includes an assessment of stressors from multiple sources and the distinct relationships with behavioral risk outcomes across these predictors for both men and women. This study also assessed the influence of a partner's experience of stress on behavioral risk, which very few studies, if any, have done. In addition, this study assessed stress crossover from both sides of the couple—many studies just focus on crossover from one member of the couple to the other.[169]

In conclusion, this study filled important gaps in the literature on the factors influencing the health behaviors of young couples expecting a baby. The findings demonstrate that experiences of stress across multiple life domains are associated with both maternal *and paternal* health behaviors among young couples during pregnancy. Interventions that address healthy coping mechanisms among this population may help reduce these unhealthy behaviors. Programs and interventions targeting prenatal health behaviors (particularly among adolescents and young adults) overwhelmingly neglect young male partners of the expectant young woman. These findings indicate that stress is associated with young men's health behaviors during this time. These health behaviors have important implications for their health into adulthood and for the health of their partner and child.

This research also revealed that young women's experiences of stress can crossover and impact the health behaviors of her romantic partner—but, not in the expected negative direction. The more stress a young expectant woman experienced in multiple domains, the less risk behavior her young male partner reported. The male partners of young expectant women can be an important source of support and may have a significant influence on the health of their pregnant partners. It is critical that programs and interventions aimed at improving young women's prenatal health behaviors include romantic partners, when feasible and desired by both members of the couple, and address the importance of the influence of this relationship on their own and their baby's health.

Chapter V. *Conclusion*

This dissertation tested dyadic models of the association between both maternal and paternal reports of relationship quality and stress during pregnancy with prenatal health behaviors and birth outcomes. It is the first research to assess the effect of direct report of paternal experiences of stress and relationship quality on birth outcomes. It is also the first research of its kind to use dyadic data analysis methods to parcel out the independent and interactive effect of each parent among couples on birth outcomes—particularly among young couples who I hypothesized may be particularly susceptible to stress and its effects on birth and child outcomes.

The first paper in this dissertation demonstrated that father's report of conflict with his partner and his presence at birth were both significantly associated with having a baby with a lower birth weight and an earlier gestational age at birth among a national sample of married and unmarried parents in a relationship. The magnitude of the effect of the father's presence at birth was similar to that of light smoking during pregnancy.   This is the first study to demonstrate an association between direct *paternal* reports of relationship conflict and birth outcomes. Research examining the impact of fathers on birth outcomes has largely been limited to demographic factors (age, race, etc.), and maternal reports of paternal involvement and support, and the measures of these constructs are almost always very crude (e.g. father's name on birth certificate).[68,217]

This paper also found an interactive effect of maternal and paternal reports of relationship conflict on birth outcomes. Average birth weight was the lowest when both parents reported high levels of conflict with their partner. Low levels of conflict as reported by mothers were protective. When mothers perceived low levels of conflict, the father's report of conflict did not have an effect on birth weight; however, when mothers reported high levels of conflict, greater paternal report of conflict was associated with worse birth outcomes.

Consistent with previous studies finding that maternal report of paternal support during pregnancy was positively associated with birth outcomes, this paper found that the baby's father's

presence at the birth predicted that their babies weighed 98.8g more at birth and had an average of 3.5 days longer gestation. The baby's father's presence at birth may be a crude indicator of his support of his partner and his involvement with the pregnancy. This finding is consistent with the theory posed by Alio and colleagues (2010) in which support from the baby's father during pregnancy may decrease maternal stress and encourage healthy behaviors, ultimately leading to better birth outcomes.[68] This finding may indicate that we may be able estimate population level effects of paternal support by using paternal attendance at the baby's birth as a proxy within analyses of nationally representative surveys, since it is a simple measure to employ.

The second paper in this dissertation did not find an association between maternal report of stress during pregnancy with either gestational age at birth or birth weight among a sample of 296 young expectant couples. The analysis did find, however, that men's experiences of stress were *positively* associated with gestational age at birth and birth weight (marginally significant), both before and after controlling for important confounders. This finding contradicted my hypothesis that men's stress would be negatively associated with birth outcomes; however, the finding does suggest that men's experiences during pregnancy matter to birth outcomes.

The results of the analyses in this paper are more consistent with the "Tend and Befriend" model of the female stress response.[164,165] This model suggests that under conditions of stress women are likely to increase their support-seeking behaviors from others, including significant others. This support seeking (also called affiliation behavior) may help reduce women's feelings of stress. Research the female neuroendocrine response to stress suggests that after the initial fight or flight response to stress, the release of oxytocin ("the love drug") is greater among females than males.[165] The increase in oxytocin may enhance affiliation behavior, reduce feelings of stress among women and ultimately lead to better birth outcomes. On the other hand, this affiliation behavior may increase her partner's stress as she leans on him for support.

Figure V-1 is a depiction of an alternative conceptual model of how maternal and paternal stressors are associated with birth outcomes based upon the "Tend and Befriend" model of the stress response among women. The paths depicted in Figure V-1 may explain the positive effect of paternal stress on birth outcomes. Under conditions of stress, expectant mothers may seek support from the father of their baby, which may cause him additional stress, but alleviate some of her stress, which would ultimately lead to better birth outcomes.
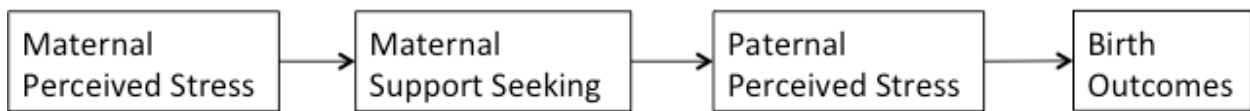

Figure V-1. Conceptual model of the positive effect of paternal stress on birth outcomes based on the "tend and befriend"[164] model of the maternal stress response.

The third paper in this dissertation found that experiences of several domains of stress were associated with greater health risk behaviors and outcomes, including substance use, conduct problems, unprotected sex and depressive symptoms, among young expectant couples. This finding concurs with vast previous research demonstrating the same effect among adolescents.[143,173–179,182,183,191–194,218–221]

The results from this analysis contradicted my hypothesis that a partner's experience of stress could crossover and negatively affect one's own health and health behaviors, based on stress and strain crossover theory.[222] The results showed that all of the significant effects of the young men's partner's stress were associated with *less* risk behavior and *more* protective behavior. This analysis also found that young men's depressive symptoms were directly associated with his partner's personal hardship stressors, a finding that is consistent with the theory of empathetic distress in which one partner takes on the experiences of stress and distressed emotions experiences it as one's own."[199] For all the negative portrayal of young expectant women's partners, the results of this analysis suggest that young

men who see that their partner is under significant stress, may empathize with their partner's troubles and may improve their health behaviors for the benefit of their partner and their new baby.

Key Finding #1: Father's experiences matter to the health of the unborn child

Together, the findings from this dissertation research suggest that father's experiences during his partner's pregnancy matter to the health of an unborn child. Over the past decade there has been increasing focus on supporting father involvement in order to promote child health and wellness, and a new call to promote investigation into paternal effects on birth outcomes[67,223,224] and paternal involvement during the perinatal period.[224,225] For example, the National Healthy Start Initiative, whose mission is to advocate "for health equity, services, and interventions that improve birth outcomes and family wellbeing," has focused in recent years on ensuring inclusion of fathers in their programs and promoting research that examines the impact of father involvement on birth outcomes and child health.[224]

Many studies have found evidence that father involvement is associated with birth outcomes.[68,102,217,226] This dissertation research went beyond prior studies that have assessed father involvement by maternal report of father's behavior (such as his financial contributions or other support or whether the father's name is birth certificate). This dissertation research treated men's experiences during pregnancy, including experiences of stress and relationship quality, with equal weight to women's experiences when it came to their impact on birth outcomes. The findings from this research suggest that men's experiences during the transition to parenthood are associated with birth outcomes—in some circumstances with positive effects and others with negative effects.

The sizes of the effects of paternal experiences during his partner's pregnancy were not negligible, either. This research found that babies born to men who reported the highest level of conflict were nearly 70 grams lighter at birth than babies born to fathers who reported the lowest level

of conflict. Additionally, babies born to fathers that were not present at their child's birth were nearly

99 grams lighter at birth.   Paternal stress was not associated with birth outcomes in the expected

negative direction among young couples. Babies born to fathers with the highest levels of paternal

stress weighed, on average, over 113 grams *heavier* at birth than babies born to fathers with the lowest

level of stress. The average negative effect of *light* smoking during pregnancy in birth weight is 160

grams,[130] which demonstrates that the effect sizes found in these analyses are meaningful.

The stress and coping framework[227] as well as the stress and strain crossover theory[222] both

suggest that experiences of stress should have been negatively associated with health generally, and

birth outcomes in particular. The positive effect of men's stress on birth outcomes coupled with the lack

of effect of maternal stress on birth outcomes, however, suggests that there may be an alternative

model for how parental stress processes among expectant couples influence birth outcomes. The "Tend

and Befriend"[164] model of the female stress response may better fit the findings in this dissertation. This

model of the stress response suggests that under conditions of stress, women are more likely than men

to affiliate with others and seek social support. Men are more likely to display behaviors that are fight-

or-flight related in response to stress, such as substance use. In fact, the final paper in this dissertation

found that association of experiences of stress with substance use were much more common among

expectant fathers than mothers. Under conditions of stress, the expectant mothers in this study may

have sought out substantial support from the father of their baby, which may have benefitted her well-

being and ultimately the baby's health. This support seeking, however, may have come at the cost of

increasing her partner's stress as she leaned on him for support. While support seeking was not

measured in the dataset used for this analysis, post-hoc analyses did find that women's stress was

significantly associated with her attachment anxiety, which was in turn significantly correlated with her

partner's stress.

It is noteworthy that the effects of father's report of relationship quality and his involvement among men in the Fragile Families population were in the expected direction: babies born to father's who reported the highest level of relationship conflict were born earlier and smaller, and babies born to fathers who were present at the birth were born later and bigger. Men in the Fragile Families study were generally older (average age was 29.7) and weighting of the dataset made the data representative of births to married and unmarried couples in large U.S. cities. The effects of father's reports of stress among men in the PARTNRS study were in an unexpected direction: greater stress was related to longer gestation and greater birth weight. Men in this study were younger (average age was 21.3) and were unmarried. It may be that young unmarried men who are expecting a baby are less equipped developmentally to deal with the stress of the pregnancy and his partner's support needs compared to older men. Young men who report the most stress may be providing the most support for his expectant partner, which may be indicative of a healthier and more committed relationship (which would ultimately support a healthier pregnancy) than young men who are less engaged and less stressed as a result. Older men who have had many more years to develop psychosocial skills may be less stressed than younger men by the support needs of his expectant partner. The stress that an older man reports about a relationship may be indicative of the most unhealthy relationships, which would lead to a less healthy pregnancy and more negative birth outcomes.

Key Finding #2: Parental relationships are associated with birth outcomes

Relationship quality has been associated with a variety of health outcomes, including cardiovascular disease,[99] inflammation[100] and impaired immune function.[100] The findings from this dissertation concur with previous research demonstrating that relationships can influence health by buffering, causing or exacerbating stress.[211] In addition, the findings extend the literature by demonstrating that relationship quality was associated with birth outcomes among a national sample of married and unmarried couples. This research showed that relationship dynamics that caused or exacerbated stress—notably couple conflict—were negatively associated with birth outcomes. Further, a marker of relationship quality and paternal support and involvement—whether the father's name was on the baby's birth certificate—was also positively associated with birth outcomes at a level that was nearly commensurate with the effect of light smoking on birth outcomes.

This research also found that there was an interactive effect of parental reports of relationship conflict on birth outcomes: the average birth weight was the lowest when both parents reported high levels of conflict with their partner. The results also showed that the mother's report of conflict was protective—when mothers perceived low levels of conflict, the father's report of conflict did not have an effect on birth weight; however, when mothers reported high levels of conflict, the greater the father's the report of conflict the worse it was for the baby. Our nation has spent the last several decades focusing on changing *maternal* behaviors during pregnancy (e.g. smoking during pregnancy and attending prenatal care) to improve population rates of low birth weight and preterm birth with little luck. This research suggests that the parental relationship and the experiences of both partners during the pregnancy have unique and important contributions to poor birth outcomes. Programs and policies that not only address the importance of healthy romantic relationships, but that also include both members of an expectant couple, may help support healthier pregnancies and lead to better birth outcomes.

Key Finding #3: Young expectant couples experience high levels of stress in their lives

There has been very little research exploring young expectant adolescents' experiences of stress during pregnancy. In fact, young expectant fathers' experiences in general during his partner's pregnancy have largely been ignored, despite the fact that his partner's pregnancy is also a major life transition for him. As if the transitions to adulthood and parenthood were not stressful enough in and of themselves, the young couples from the PARTNRS study also reported experiencing many stressors during the pregnancy, ranging from individual experiences (e.g. job loss), interpersonal exposures (e.g. conflict in a steady relationship), neighborhood conditions (e.g. crime in neighborhood), to societal context (e.g. racism).

Nearly half of all PARTNRS women and men reported problems with money in the previous 6 months, and one-third of the young men reported being unemployed as a stressor. Over one-third of the young women reported moving within the previous six months. In a post-hoc analysis of the PARTNRS data, over 75% of the young men and women experienced at least one (out of eleven) stressful life events in the previous 6 months. Seventy-nine percent of young men and women reported experiencing discrimination in their daily lives. Over 78% of men and 75% of young women reported at least one minor or serious neighborhood problem (out of fifteen), including assault and muggings and feeling unsafe after dark.

When developing and implementing programs and policies that may help improve relationships and mitigate stress during pregnancy, practitioners must always consider that the main focus of the program maybe not ultimately be the main stressor or focal point in the participants' lives. Adolescents and young adults who are racial and/or ethnic minorities, live in urban areas and are from a low socioeconomic status (SES), are disproportionately affected by severe and chronic stressors, such as financial stressors, neighborhood problems, racism and discrimination.[38] Programs and policies that fail to address these fundamental issues may not see success in improving outcomes because they fail to

incorporate what may be the main drivers of the outcomes in the first place. Even worse, programs and policies that do not address these fundamental issues may inadvertently cause unexpected negative outcomes.

Key Strengths

While there is substantial previous research exploring the effect of maternal stress on birth outcomes, this dissertation was the first to explore the effect of *paternal* stress on birth outcomes, and the pathways through which he has an effect. This analysis assessed direct report of stress exposures and responses from the fathers, avoiding measurement error associated with using maternal reports of paternal experiences. This analysis also explored multiple sources of stress in an effort to parcel out which stressors had an effect on birth outcomes. This analysis was also the first to explore how multiple dimensions of relationship quality, beyond more crude measures such as marital status, affect birth outcomes among married and unmarried families.

The analytical techniques used in this research also strengthened the analyses. Each analysis accounted for the correlated nature of maternal and paternal reports, while maintaining the strength of the total sample size (i.e. without conducting the analyses separately by gender). In addition, one of the analyses used structural equation modeling, which allowed for the simultaneous assessment of multiple hypotheses involving complex pathways, while parceling out measurement error. Another analysis employed multilevel modeling (with the Actor Partner Interdependence Model[210] as a framework), which used a single analysis to incorporate responses from both members of a couple and treated the members of a couple as nested scores within the same group.

Key Limitations and Suggestions for Future Research

While this dissertation has many strengths, it is not without limitation. Because the analyses were all secondary, I was limited by the study design and the measures collected for both datasets (Fragile Families and PARTNRS). Neither study was nationally representative, although the Fragile Families study was a national sample that was representative of births in large U.S. cities. Therefore, the ability to generalize the findings may be limited to the populations studied.

Additionally, issues related to the timing of assessments were of concern in all analyses. In the Fragile Families study, parents' report of their relationship quality was assessed shortly after the birth of the baby, raising concern over the issue of reverse causality. For example, a poor birth outcome (having the baby earlier than 38 weeks) may cause parents stress, which may cause them to think and report more negatively about their relationship over the final month of pregnancy. In the PARTNRS study, experiences of stress and depressive symptoms were assessed at the same time point, limiting our ability to establish directionality in the analysis of whether depressive symptoms mediated the effect of stress on birth outcomes. These paths are guided by theory, however, and the time frames referenced by each measure make the direction of the effects plausible. The PARTNRS study, however, allowed for longitudinal assessment of the effects of stress on birth outcomes because the birth outcomes were collected from medical records, while the self-report of stress were ascertained during the second and third trimesters of pregnancy.

Another limitation is that the studies did not collect data on stress appraisal and perception. Future studies would be strengthened by the inclusion of stress appraisals and perceptions. What is stressful for one person may not be stressful for another, and therefore the likelihood of reporting a stressful event may be affected by an individual's appraisal of the stressor.[69] Measures of stress appraisals and perceptions could ascertain the individual's perception and evaluation of potential harm posed by a specific external demand (i.e. stressor) and their ability to cope with the demand.[70] The

inclusion of biological indicators of stress responses may also help show whether a stressor actually has a physiological effect on the expectant mother that could ultimately affect the health and development of the fetus.[14]

Another concern is whether there are important omitted variables that could explain the association between relationship quality and stress, with the birth outcomes. Unfortunately, due the limitations of the study designs and measures collected, we cannot separate out unmeasured confounding of the association between relationship quality and stressors with birth outcomes by some other parental characteristic (e.g. personality, depression) that would affect both the report of exposures and outcome. Given the substantial evidence that has documented an association between relationships quality and general health,[(e.g. 62,99,100)] and stress and birth outcomes[(e.g. 27,28,31–34,43)] the results from this this study are plausible; however, future studies that are longitudinal and collect measures of these other characteristics would strengthen the validity of the findings.

Implications for Future Research, Programs and Policies

Despite the importance of male partners during pregnancy, very little research has explored paternal influences on birth outcomes.[37] Research examining the effects of paternal factors on birth outcomes has been mostly limited to demographic factors (e.g. advanced age, race/ethnicity, etc.) and maternal reports of paternal involvement and support, and these measures are often crude (e.g. father's name on birth certificate).[68,217] Researchers and clinicians have almost entirely focused on how women's experiences, behaviors, and physical and mental health are associated with birth outcomes. This lack of inclusion of men in research during the antenatal period is reflective of the gender biases that are evident in mainstream American culture and parenting norms.[228] American culture largely views pregnancy and child care as a women's responsibility.[228] As such, programs and policies are almost

entirely focused on improving women's health and behaviors during pregnancy, with the female as the sole recipient of the intervention or target of the policy. By continuing to focus birth outcome research on women only, we may be inadvertently perpetuating this construction of pregnancy and child health as a largely maternal responsibility, while men are seen (and treated) as unimportant in their capacity to influence the health of their unborn child.[228] The results of this research demonstrate that men's experiences during pregnancy are important (and substantial) predictors of birth outcomes. As such, future research studies that investigate psychosocial influences on birth outcomes should include both maternal and paternal experiences.

Future investigations would be strengthened by inclusion of direct report from the expectant fathers so as to reduce measurement error associated with maternal report of paternal factors. Obtaining direct report from fathers may not be easy due to existing barriers to paternal engagement during the prenatal period. Due to cultural, institutional and policy biases around maternity care, men are marginalized at the outset of the prenatal period. Thus, future studies need to recruit men directly, not just through the mothers, and offer flexible hours or home visits for their participation in the research. Further, welcoming the expectant fathers personally and communicating the potential advances that may result from the fathers' participation in the research may go a long way in successful recruitment and retention of expectant fathers. The PARTNRS and Fragile Families studies used these strategies to maximize the engagement of the expectant and new fathers with great success.

Additionally, there should be parity in the data collected from expectant mothers and fathers (i.e. the same questions are asked of both parents), which would allow for the use of dyadic data analysis methods, such as those employed in this dissertation. Dyadic data analysis methods can help parcel out the maternal, paternal and couple level effects on birth outcomes.

Because relationships, stress, mental health and other psychosocial factors are inherently affected by significant others, programs to improve birth outcomes and early child health that target

only the expectant mother seem unlikely to be effective or effect change that is sustainable. Couples-based programs to improve birth outcomes may be more effective than programs that include mothers only. There has been very little investigation into the effectiveness of couples-based interventions on improving birth outcomes. The Family Foundations' couples-based intervention for expectant parents is the only intervention, to my knowledge, that has been evaluated in its effectiveness in improving birth outcomes. Family Foundations is delivered in a group format and aims to provide psychosocial support and education, with the goal of preparing couples to enter parenthood together in a supportive manner.[229] When evaluated, Feinberg et. Al. (2015) found that among women with the highest levels of cortisol, the Family Foundation intervention reduced the incidence of adverse birth outcomes, including preterm birth and low birth weight.[229] The development and evaluation of theory- and evidence-based couples interventions may help improve the rates of adverse birth outcomes in the future.

Appendices

Appendix II-1. Variable descriptions and details.

Construct	Measure and Reference	Description	Response Scale	Time Points Assessed	Time Frame Referenced	Summary Measure
Exposures: Relationship Quality						
Positive Couple Activities	Original to Fragile Families	4 items asked whether they had done positive activities with baby's father/mother (e.g. went out to a movie, helped each other solve a problem)	1=Yes 0=No	Baseline	Last month	-Responses summed to form an index -Higher scores correspond to more positive activities (range: 0-4) (α=0.64 w, 0.60 m)
Couple Conflict	Adapted from National Survey of Family Health[121]	6 items assessed frequency of disagreements about specific topics (e.g. money, sex, being faithful)	1= never 2= sometimes 3= often	Baseline	Last month	-Responses summed to form a continuous scale -Higher scores correspond to more disagreement/more conflict (range: 6-18) (α=0.65 w, 0.64 m)
Partner Support	Adapted from Multidimensional Support Scale (MDSS)[122,123] and Susan Loyd's Effects of Violence on Work and Family project.	4 items assessed frequency of supportive and destructive behavior toward respondent by the baby's father/mother (e.g., s/he is fair and willing to compromise, s/he insults or criticizes you or your ideas)	1= often 2= sometimes 3= never	Baseline	Current	-Responses summed to form a continuous scale -Supportive behaviors were reverse scored. -Higher scores correspond to more partner support (range: 4-12) (α=0.60w, 0.59 m)
Relationship Satisfaction	Original to Fragile Families	6 items ask how life might be different if they were married to the baby's father/mother (for unmarried) or not married to the baby's father/mother (for married) (e.g. financial security, happiness)	4-point scale ranging from 5=much worse to 1=much better	Baseline	Current	-Responses summed to form a continuous scale -Responses from unmarried respondents were reverse scored. -Higher scores correspond to more partner/relationship satisfaction (range: 6-30) (α=0.72 w,0 .67m)
BF present at birth	--	Asked baby's father whether he was present at the birth	1=Yes 0=No	Baseline	--	Dichotomous

Relationship Duration	--	Asked mothers years and/or months they knew the baby's father before the pregnancy	Months	Baseline	--	Continuous (range: 0-432)
Birth Outcomes						
Birth Weight	Weight at birth	--	Grams	Medical Records	--	Continuous (range : 470-5,585)
Gestational Age at Birth	Weeks pregnant at birth	--	Weeks	Medical Records	--	Continuous (range: 23-46)
Effect Measure Modifier						
Marital Status	--	Asked whether currently married to father of the baby	1=Yes 2=No	Baseline	Current	Dichotomous
Confounders (Maternal and Paternal)						
Age	--	Summary variable created by FF from birth date.	--	Baseline	Current	Continuous (range:15-43 women 15-53 men)
Household Income	--	Asks: "Thinking about your income and the income of everyone else who lives with you, what was your total household income before taxes in the past 12 months?"	1= < $5,000 2= $5,000 to $9,999 3= $10,000 to $14,999 4= $15,000 to $19,999 5= $20,000 to $24,999 6= $25,000 to $34,999 7= $35,000 to $49,999 8= $50,000 to $74,999 9= > $75,000	Baseline	Current	Categorical
Education	--	Asks the highest grade or year of regular school that they have completed.	1= < high school 2= high school/equiv 3= some coll, tech 4= coll or grad	Baseline	Current	Categorical
Race/Ethnicity	--	Asks which category best describes their race and ethnicity.	1= White 2= Black 3= Hispanic 4= Other	Baseline	Current	Categorical
MATERNAL ONLY						
Parity	--	From medical record *before* the index child was born.	--	Baseline & Medical Records	Current	Continuous (range: 0-12)
Paid for birth with	--	Payment for delivery	1=Yes	Medical Records	--	Dichotomous

Medicaid or was uninsured		indicated as Medicaid, partial Medicaid, Uninsured or other government program	0=No			
Smoking During Pregnancy	--	Mother smoked cigarettes during pregnancy, from all possible sources in the medical record	1=Yes 0=No	Medical Records	During Pregnancy	Dichotomous
Drug Use During Pregnancy	--	Mother used drugs during pregnancy, from all possible sources in the medical record	1=Yes 0=No	Medical Records	During Pregnancy	Dichotomous
Alcohol Use During Pregnancy	--	Mother used alcohol during pregnancy, from all possible sources in the medical record	1=Yes 0=No	Medical Records	During Pregnancy	Dichotomous
Trimester Prenatal Care Initiated	--	Variable constructed by FF that indicates the trimester prenatal care was initiated	1= First Trimester 2=Second Trimester 3=Third Trimester	Medical Records	During Pregnancy	Categorical
Mental Illness Pre-Pregnancy	--	Mother had pre-pregnancy diagnosis of mental illness, from all possible sources in medical record	1=Yes 0=No	Medical Records	Pre-Pregnancy Diagnosis	Dichotomous
Pre-Existing Diabetes	--	Mother had pre-pregnancy diagnosis of diabetes, from all possible sources in medical record	1=Yes 0=No	Medical Records	Pre-Pregnancy Diagnosis	Dichotomous
Pre-Existing Hypertension	--	Mother had pre-pregnancy diagnosis of hypertension, from all possible sources in medical record	1=Yes 0=No	Medical Records	Pre-Pregnancy Diagnosis	Dichotomous
Time between Mother and Father Interviews	--	Days between parental interviews	Days	Baseline	After Delivery	Continuous (range: 0-32)

Appendix II-2. Measure details, validity and reliability

The following summary variables were created using items from the Fragile Families and Child Well Being Study Baseline Survey of Parents.[230]

Positive Couple Activities

The following 4 items comprising the positive couple activities measure were developed for the Fragile Families study. The 4 questions listed below asked parents whether they had done positive activities with the baby's father/mother in the last month or the last month they were together (1=Yes, 0=No). A total positive couple behavior score was created by summing the responses (α =0.64 mothers and 0.60 fathers; range 0-4).

> *I'm going to read you some things that couples often do together. Tell me which ones you and [BABY'S FATHER/MOTHER] have done together in the past month*
> 1. *visited with friends*
> 2. *went out to a movie, sporting event, or some other entertainment*
> 3. *ate out in a restaurant*
> 4. *helped each other solve a problem*

No specific validity information is provided by the principal investigators; however, this measure has been successfully employed as an indicator of relationship quality using Fragile Families data. A study among adolescents and young adults in the Fragile Families study used the four items assessing joint participation in activities together (KR20=.67 for fathers; KR20=.74 for mothers). More positive couple activities reported by the mother predicted more father involvement 3 years later.[231]

Couple Conflict

This measure was loosely adapted from the National Survey of Family Health.[121] Questions asked parents how often they had disagreements about six topics listed below. Parents responded on a three point scale ranging from 3=often, 2=sometimes, 1=never. Responses were summed to form a

continuous score, with higher scores indicating less conflict and more agreement in the relationship

(chronbach's α= 0.65 mothers and 0.64 fathers; range 6-18).

The following is a list of subjects on which couples often have disagreements. How often, if at all, in the last month have you and [BABY'S FATHER/MOTHER] had disagreements about each of the following:
  1. *money*
  2. *spending time together*
  3. *sex*
  4. *the pregnancy*
  5. *drinking or drug use*
  6. *being faithful*

Results of formal tests of the measure's validity have not been reported, however, several

analyses of Fragile Families data have used this measure as an indicator of relationship quality. A study

assessing relationship conflict and union formation used the 6 items about relationship conflict. The

frequency of conflict was represented by the mean of parents' reports about whether they "never" (1),

"sometimes" (2), or "often" (3) had conflict over the six items in the last month. Reports of conflict had

inconsistent effects. Only father's reports of conflict significantly deterred cohabitation.[232] No

chronbach's alpha was reported.

Another study found that couple conflict measured using maternal report of these items

(chronbach's α =0.65) predicted poor maternal prenatal health behaviors.[233] A study among adolescents

and young adults in the FF study used conflict items (α =0.64 mothers and 0.62 fathers) to predict father

involvement. Disagreements reported by both mothers and fathers were not significantly associated

with father involvement 3 years later.[231]

Partner Support

This measure was loosely adapted from the Winefield et al. Multi-Dimensional Support Scale (MDSS; 1992).[122,123] Five questions asked parents how often the mother or father of their baby displayed supportive or destructive behavior toward the respondent. Parents responded on a three point scale ranging from 1=often, 2=sometimes, 3=never about the items listed below. Support (positive) behaviors were reverse-scored when creating a total score, which summed the responses. Higher scores indicate more supportive and less destructive behaviors toward the respondent. Factor analysis using maximum likelihood indicated that the "s/he hits or slaps you when angry" item did not load above 0.32 (standard threshold)[234] on to the partner support factor. Therefore, this item was excluded and a four-item variable using the other items was created (α =0.60 mothers and 0.59 fathers; range 4-12).

> *Thinking about your relationship with [BABY'S FATHER/MOTHER], how often would you say that:*
> 1. *s/he is fair and willing to compromise when you have a disagreement*
> 2. *s/he hits or slaps you when angry (*not include in summary variable)
> 3. *s/he expresses affection or love for you*
> 4. *s/he insults or criticizes you or your ideas*
> 5. *s/he encourages or helps you do things that are important to you*

Alpha coefficients are generally high for the MDSS (>.75) and the subscale scores correlate well with affect measures (e.g. depressive affect, self-esteem, psychological disturbance).[123]

Several analyses of Fragile Families data have used this measure, in different forms, as an indicator of relationship quality. A 9-item version was used 1 year postpartum among Fragile Families Fathers. These 9 items included the 5 items assessed at baseline. The author dichotomized the outcome (sometime and often vs. never). Chronbach's α was 0.90 for married fathers and 0.93 for unmarried fathers. Relationship quality predicted perceptions of co-parental support for married fathers but not unmarried fathers.[235]

A 6-item version (which included the 5 items included in this analysis) was used 1 year postpartum among Fragile Families mothers and fathers. Authors averaged the scores for mothers and fathers (chronbach's α =0.76). Better relationship quality predicted greater parental engagement in infant and toddler years, with married and cohabiting couples similar in the association.[236]

A 4 item version ("insults or criticizes you or your ideas,""expresses affection or love for you," "is fair and willing to compromise," and "encourages and helps you to do things.") using baseline assessments from all mothers significantly predicted (chronbach's α =0.66) breastfeeding rates only among African Americans.[237]

Relationship Satisfaction

The items for this measure were developed specifically for the Fragile Families Study. The six items ask how life might be different if they were married to the baby's father/mother (for unmarried couples) or *not* married to the baby's father/mother for the married couples). Couples reported responses to the following items on a scale from 1=much better to 5=much worse. The responses for unmarried respondents were reverse scored with the theory that if they rated that the items would be worse with marriage, they were demonstrating a lack of satisfaction with their partner and/or relationship. Coding for responses for married respondents were maintained because if they rated that the items would be much worse if they were not married to the baby's father/mother, it shows they are more satisfied with their partner and/or relationship. A total relationship status satisfaction score was created by summing the responses. Higher scores indicate more satisfaction with their partner and/or relationship (α =0.72 mothers and 0.67 fathers; range 6-30).

If you were/were not married, how would life be different in terms of:
1. *financial security*
2. *overall happiness*
3. *freedom to do what you want*
4. *control over money*
5. *sex life*
6. *relations with parents*

No Fragile Families analyses to my knowledge have used these questions as a summary measure representing relationship quality. Therefore, this dissertation is a novel use of these questions as a representation of relationship quality.

Appendix III-1. Outcome and confounder descriptions and details

Construct	Measure	Description	Response Scale	Time Points Assessed	Time Frame Referenced	Summary Measure
Birth Outcomes						
Birth Weight	Weight at birth in grams	--	--	At birth via labor log	--	Continuous
Gestational Age at Birth	Weeks pregnant at birth	--	--	At birth via labor log	--	Continuous
Mediator						
Depressive Symptoms	Center of Epidemiological Studies-Depression Scale (CES-D)[91] (adapted)	15 items assessed how often experienced the depressive feeling or thought (e.g. I felt depressed, had crying spells) -Five behavioral manifestations of depression items were removed	4-point scale ranging from 0 ("Rarely or none of the time (less than 1 day") to 3 ("Most of the time (5-7 days)")	Base (24-40 weeks pregnant)	Past Week	-Responses summed to form a continuous scale -Higher scores correspond to more depressive symptoms (range: 0-45) ($\alpha = 0.84$, $\alpha = 0.78$ m)
Confounders (Maternal and Paternal)						
Age	--	Summary variable created by from birth date.	--	Baseline	Current	Continuous
Household Income	--	Asks: " What is your household income (the total income before taxes earned by all members of your household) per year)	0 $0-$4,999 1 $5,000-$9,999 2 $10,000-$14,999 3 $15,000-$19,999 4 $20,000-$24,999 5 $25,000-$34,999 6 $35,000-$49,999 7 $50,000 or more	Baseline	Current	Categorical

Construct	Measure	Description	Response Scale	Time Points Assessed	Time Frame Referenced	Summary Measure
School or Work Status	--	A summary measure created to indicate if the participant is either in school and/or working at least part-time.	1=Yes 0=No	Baseline	Current	Dichotomous
Race/Ethnicity	--	Variable constructed from two questions, the first asking their race (select all) and the second asking if they are Hispanic or Latino. Coded as black if selected black (regardless of ethnicity), Hispanic if selected Hispanic or Latino (regardless of race), white if they selected white only. All other participants were grouped into the "Other" category due to low sample size.	1= White 2= Black 3= Hispanic 4= Other	Baseline	Current	Categorical
Confounders (Maternal Only)						
Parity	--	Question in baseline interview	--	Baseline	Current	Continuous
Clinical Risk	--	Variable constructed from 5 yes/no items: Presence of gestational diabetes and pre-eclampsia as indicated on the labor log, having a pre-pregnancy BMI classified as obese based on height and weight questions from baseline interview, reporting no prenatal care by the time of the baseline interview and a positive urine test for chlamydia and/or Gonorrhea at the baseline interview.		Baseline and at birth via labor log	During Pregnancy	Continuous (range 0-5)

Construct	Measure	Description	Response Scale	Time Points Assessed	Time Frame Referenced	Summary Measure
BMI pre-pregnancy	--	Calculated from participant report of pre-pregnancy weight and current height.	--	Baseline	Pre-Pregnancy	Continuous
Baby's Gender	--	--	1=Male 2=Female	At birth via labor log	--	Dichotomous

Appendix III-2. Variable details, items, validity and reliability

Stressful Life Events

This 11-item scale was adapted from the 12-item Life Events Scale, which was created by Brugha and Cragg (1990).[151] This scale asks participants if they have experienced stressful life events in the previous 6 months. Ten items out of the original 12-items were incorporated into the questionnaire, however, three original items were revised: "You became unemployed or you were seeking work unsuccessfully for more than one month" was changed to "In the past 6 months, did you become unemployed or were seeking work unsuccessfully," "You had a major financial crisis" was changed to simply "In the past 6 months, did you have money problems," and "You had problems with the police and a court appearance" was changed to "In the past 6 months, did you have problems with the police." Additionally, two questions were combined and changed into one question: "Your parent, child or spouse died" and "A close family friend or another relative (aunt, cousin, grandparent) died" were combined and shortened into "In the past 6 months, did a close family member or friend die."

Additionally two items were added for the research study including: "In the past 6 months, did you have problems at work or school," and "In the past 6 months have you moved." Two of the original items from the LEQ were also omitted from the research study including: "You had a separation due to marital difficulties" and "You were sacked from your job."
The 11 items were summed to form a total score.

The test-retest reliability of the Life Events Scale is reported as .84 for a three-month period and .66 for a six-month period. Data on internal consistency are not available. Concurrent validity estimates were derived from the concordance between inpatient psychotic patients' identification of stressful events and those identified by a significant other; there was a 90% agreement when assessed at a three-month period and a 70% agreement when assessed at six months. The authors also used an extensive interview of stressful events as a base rate and showed that the LEQ was sensitive to the identification of stressful events.[151]

Items:
In the past 6 months:
        have you suffered a serious illness, injury, or assault?
        did a close relative suffered a serious illness, injury, or assault?
        did a close family member or friend die?
        you break off a steady relationship?
        did you have a serious problem with a close friend, neighbor, or relative?
        did you become unemployed or were seeking work unsuccessfully?
        did you have money problems?
        did you have problems with the police?
        did you have problems at work or school?
        was something you valued was lost or stolen?
        have you moved?

General Discrimination

An adapted version of the Daily Life Experiences Scale was used to assess participant experiences of discrimination.[152] The original Daily Life Experiences Scale has 20-items, however the adapted version used 19 of those items. The items how often the survey taker has experienced discrimination (e.g. Being observed or followed in public places). The response scale ranged from 0 to 5: 0= "never," 1= "less than once a year," 2= "a few times a year," 3= "about once a month," 4= "a few times a month," and 5 = "once a week or more." Responses to items were summed to form a total score ranging from 0-95.

Four items from the original scale were also revised, including "Being mistaken for someone else of your same race (who may not look like you at all)" was changed to "mistaken for someone else (who may not look like you at all)" and "Being asked to speak for or represent your entire racial/ethnic group (e.g. What do ___people think?)" was changed to "asked to speak for or represent an entire group (e.g. What do ___people think?), "Overhearing or being told an offensive joke or comment" was changed to "hear an offensive joke or comment" and "Being avoided, others moving away from you physically" was changed to "avoided, or do others move away from you physically." There was also one item added: "Someone in the health system showed you hostility or a lack of respect, refused you service or paid less attention to you compared with others" and one item was omitted "Being considered fascinating or exotic by others."

Items
In general, how often are you ignored, overlooked, or not given service (in a restaurant, store, etc.)?
In general, how often are you treated rudely or disrespectfully?
In general, how often are you accused of something or treated suspiciously?
In general, how often are you do others react to you as if they were afraid or intimidated?
In general, how often are you observed or followed while in public places?
In general, how often are you treated as if you were "stupid", being "talked down to"?
In general, how often are your ideas or opinions minimized, ignored, or devalued?
In general, how often do you hear an offensive joke or comment?
In general, how often are you insulted, called a name, or harassed?
In general, how often do others expect your work to be inferior?
In general, how often are you not taken seriously?
In general, how often are you left out of conversations or activities?
In general, how often are you treated in an "overly" friendly or superficial way?
In general, how often are you avoided, or do others move away from you physically?
In general, how often are you mistaken for someone who serves others (i.e., janitor, bed boy, maid)?
In general, how often are you stared at by strangers?
In general, how often are you laughed at, made fun of, or taunted?
In general, how often are mistaken for someone else (who may not look like you at all)?
In general, how often are you asked to speak for or represent an entire group (e.g., "What do _____ people think?")?
In general, how often has someone in the health system showed you hostility or a lack of respect, refused you service or paid less attention to you compared with others?

Perceived Stress

This 10-item Perceived Stress Scale (PSS) assessed the degree to which individuals perceive situations in their lives to be stressful.[87] The items focused on how unpredictable, uncontrollable, and overloaded individuals perceive their lives to be. The participant was asked to rate the perceived level of stress in their life during the past month (e.g., "How often have you felt: upset by something that happened unexpectedly, able to control irritations in your way, and on top of things"). Possible responses ranged from 0 to 4, with 0 = "never," 1 = "almost never," 2 = "sometimes," 3 = "fairly often," to 4 = "very often." Positive items were reverse-scored. Items were summed to form a total score ranging from 0 to 40, with higher scores corresponding to greater perceived stress.

Early studies found that the 14-item measure has good psychometric properties. For example, Cohen and colleagues (1983) reported coefficient alpha reliabilities of .84, .85, and .86 across two samples of college students and a community smoking cessation group.

Early studies also found that the PSS was moderately related to responses on other measures of appraised stress, as well as to measures of potential sources of stress as assessed by event frequency. Studies also found that the PSS provided better predictions for individual behavior than did life-event scales of psychological symptoms, physical symptoms, and utilization of health services. Because levels of perceived stress should be influenced by daily hassles, the predictive validity of the PSS is expected to fall off rapidly after four to eight weeks.[87]

Items

In the past month, how often have you felt…

Upset by something that happened unexpectedly?

Unable to control important things in your life?

Nervous and stressed?

Confident in your ability to handle your personal problems? r

That things were going your way?r

Unable to cope with all of the things you had to do?

Able to control irritations in your life? r

On top of things? r

Angry because of things that happened that you couldn't control?

That difficulties were piling up so high that you couldn't overcome them

r=reverse coded

Depressive Symptoms

Fifteen items were adapted from the 20-item Center for Epidemiologic Studies Depression Scale (CES-D), which was developed by Radloff (1977).[91] The items address whether the participant felt or exhibited the behavior of the major components of depression in the previous week (e.g. I felt that everything I did was an effort). As the original CES-D scale specified, participants were asked to respond using: 0= "rarely or none of the time (less than 1 day)," 1= "some or a little of the time (1-2 days)," 2 = "Occasionally or a moderate amount of the time (3-4 days)," and "Most or all of the time (5-7 days)." The five behavioral manifestations of depression items were removed, including item did not feel like eating, trouble keeping mind on what I was doing, everything I did was an effort, my sleep was restless, and could not get going.

The CES-D scale discriminates strongly between patient and general population groups, be sensitive to levels of severity of depressive symptomatology, and reflect improvements after psychiatric treatment. In addition, it should correlate well with other scales designed to measure depression, and be related to a felt need for psychiatric services.[91]

The CES-D scale has been found to have high internal consistency (coefficient alpha =.85 in the general population and .90 in the patient sample); studies found that both inter-item and item-scale correlation were higher in the patient sample than in the population samples. The scale also has moderate test-retest reliability (r between .45 and .70). Test-retest correlation was higher for shorter time intervals.[91]

Items

During the past week…

I was bothered by things that usually don't bother me.
I felt I could not shake off the blues even with help from my family or friends.
I felt that I was just as good as other people.r
I felt depressed.
I felt hopeful about the future. r
I thought my life had been a failure.
I felt fearful.
I was happy. r
I talked less than usual.
I felt lonely.
People were unfriendly.
I enjoyed life. r
I had crying spells.
I felt sad.
I felt that people disliked me.

r=reverse coded

Appendix III-3. Multi-level linear regression models with natural log transformed outcomes

Multi-level linear regression models examining relationship between stressors (own and partner's) and natural log transformed behavioral risk and depressive symptoms. All models control for age, education, income, race/ethnicity, parity and employment status**.**

	Smoking			Drinking			Marijuana Use			Hard Drug Use[a]			Conduct Problems			Depressive Symptoms		
	B	SE	t	B	SE	t	B	SE	t	B	SE	t	B	SE	t	B	SE	t
Personal Hardship Stressors																		
Actor	**.25***	**.11**	**2.28**	**.14‡**	**.07**	**1.89**	.07	.07	.92	.01	.09	.09	**-.02***	**.01**	**-4.10**	**.45***	**.22**	**2.01**
Partner	-.16	.10	-1.56	**-.12‡**	**.06**	**-1.92**	-.02	.07	-.26	-.05	.10	-.51	-.00	.01	-.64	.34	.23	1.52
Close Relationship Stressors																		
Actor	-.01	.15	-.09	.09	.10	.89	.15	.10	1.5	**.46**	**.13**	**3.43**	-.01	.01	-1.57	.49	.33	1.49
Partner	-.04	.15	-.44	-.01	.10	-.07	.08	.10	.76	-.12	.13	-.90	-.01	.01	-1.59	.50	.33	1.54
Neighborhood Problems																		
Actor	**.05**	**.02**	**2.92**	.01	.01	.80	.02	.01	1.84‡‡	-.01	.01	-.50	-.00	.00	-.93	**.07***	**.04**	**1.98**
Partner	-.00	.02	-.07	-.02	.01	-1.41	.00	.01	.21	-.01	.02	-.76	.00	.00	.35	-.04	.04	-1.06
General Discrimination																		
Actor	.12	.16	.73	.17	.11	1.44	**.23***	**.12**	**2.0**	**.29***	**.12**	**2.47**	**-.05***	**.01**	**-6.77**	**1.39***	**.33**	**4.21**
Partner	.14	.15	.93	.00	.09	.03	-.13	.10	-1.40	.13	.16	.81	-.00	.02	-.52	-.16	.35	-.47

* P<.05 ** P≤ 0.01 *** P≤ 0.001 ‡ P=.06 ‡ P=.06 ‡‡ P=.07

[a]Only reported for men

Appendix IV-1. Outcome and Confounder descriptions and details

Construct	Measure	Description	Response Scale	Time Points Assessed	Time Frame Referenced	Summary Measure
Outcomes						
Smoking	Recreational Drug Use Scale[153]	Frequency of smoking	5-pt scale ranging from 0 "Never" to 4 "Every Day."	Baseline	Past 3 months	--
Drinking	Recreational Drug Use Scale[153]	Frequency of drinking alcohol	5-pt scale ranging from 0 "Never" to 4 "Every Day."	Baseline	Past 3 months	--
Marijuana Use	Recreational Drug Use Scale[153]	Frequency of smoking marijuana	5-pt scale ranging from 0 "Never" to 4 "Every Day."	Baseline	Past 3 months	--
Hard Drug Use	Recreational Drug Use Scale[153]	Frequency of use of crack, heroin, methamphetamines, and "other hard drugs"	5-pt scale ranging from 0 "Never" to 4 "Every Day."	Baseline	Past 3 months	Items were summed to form a total *hard drug use* score (range: 0 to 16)
Conduct Problems	DSM Conduct Problems Scale[209]	Assessed whether participant engaged in conduct problems such as got in a fight or skipped school or work.	4-point scale ranging from 1= "5 or more times" to 4= "Not at all."	Baseline	Past 6 months	7 items were summed to form a total score with higher scores indicating fewer problems (range: 7-28)
Depressive Symptoms	Center of Epidemiological Studies-Depression Scale (CES-D) [51] (adapted)	15 items assessed how often experienced the depressive feeling or thought (e.g. I felt depressed, had crying spells) -Five behavioral manifestations of depression items were removed	4-point scale ranging from 0 ("Rarely or none of the time (less than 1 day") to 3 ("Most of the time (5-7 days)")	Base (24-40 weeks pregnant)*	Past Week	-Responses summed to form a continuous scale -Higher scores correspond to more depressive symptoms (range: 0-45) ($\alpha = 0.84$, $\alpha = 0.78$ m)

Construct	Measure	Description	Response Scale	Time Points Assessed	Time Frame Referenced	Summary Measure
Confounders (Maternal and Paternal)						
Age	--	Summary variable created by from birth date.	--	Baseline	Current	Continuous
Personal Income	--	Asked: " What is your personal income (the total income before taxes earned by you only per year)	0 $0-$4,999 1 $5,000-$9,999 2 $10,000-$14,999 3 $15,000-$19,999 4 $20,000-$24,999 5 $25,000-$34,999 6 $35,000-$49,999 7 $50,000 or more	Baseline	Current	Categorical
Employed	--	Asked: "Are you currently employed?"	1 Not working 2 Working Part-time 3 Working Full-time	Baseline	Current	Categorical
In School	--	A summary measure created to indicate if the participant is either in school and/or working at least part-time.	1 Yes 0 No	Baseline	Current	Dichotomous
Years School	--	Greatest number of years of education completed	Values of 1-12 indicate years of primary or secondary school education completed. If marked "Some college", they were given a value of 14. If marked that they "Graduated college" they were give a value of 16. If marked "Some graduate or professional school"	Baseline	Current	1-20

Construct	Measure	Description	Response Scale	Time Points Assessed	Time Frame Referenced	Summary Measure
			they were give a value of 18. If marked "Completed graduate or professional school" they were given a value of 20.			
Race/Ethnicity	--	Variable constructed from two questions, the first asking their race (select all) and the second asking if they are Hispanic or Latino. Coded as black if selected black (regardless of ethnicity), Hispanic if selected Hispanic or Latino (regardless of race), white if they selected white only. All other participants were grouped into the "Other" category due to low sample size.	1= White 2= Black 3= Hispanic 4= Other	Baseline	Current	Categorical
Confounders (Maternal Only)						
Parity (First Child)	--	Assessed # of biological children the respondent had	--	Baseline	Current	A dichotomous variable was created indicating whether the index child was their first child or not 0=No 1=Yes

Appendix IV-2. Variable details, items, validity and reliability

Stressful Life Events

This 11-item scale was adopted from the 12-item Life Events Scale, which was created by Brugha and Cragg (1990).[49] This scale asks participants if they have had stressful life events. 10-items out of the original 12-items were incorporated into the questionnaire, however, three original items were revised: "You became unemployed or you were seeking work unsuccessfully for more than one month" was changed to "In the past 6 months, did you become unemployed or were seeking work unsuccessfully," "You had a major financial crisis" was changed to simply "In the past 6 months, did you have money problems," and "You had problems with the police and a court appearance" was changed to "In the past 6 months, did you have problems with the police." Additionally, two questions were combined and changed into one question: "Your parent, child or spouse died" and "A close family friend or another relative (aunt, cousin, grandparent) died" were combined and shortened into "In the past 6 months, did a close family member or friend die."

Additionally 2-items were added for the research study including: "In the past 6 months, did you have problems at work or school," and "In the past 6 months have you moved." Two of the original items from the LEQ were also omitted from the research study including: "You had a separation due to marital difficulties" and "You were sacked from your job."

The test-retest reliability of the Life Events Scale is reported as .84 for a three-month period and .66 for a six-month period. Data on internal consistency are not available. Concurrent validity estimates were derived from the concordance between inpatient psychotic patients' identification of stressful events and those identified by a significant other; there was a 90% agreement when assessed at a three-month period and a 70% agreement when assessed at six months. The authors also used an extensive interview of stressful events as a base rate and showed that the LEQ was sensitive to the identification of stressful events.[49]

Two subscales were created for use in this study: **personal hardship stressors** and **close relationship stressors**. The items in each subscale are listed below.

Items:

In the past 6 months:

Personal hardship stressors

    have you suffered a serious illness, injury, or assault?

    did you become unemployed or were seeking work unsuccessfully?

    did you have money problems?

    did you have problems with the police?

    did you have problems at work or school?

    was something you valued was lost or stolen?

    have you moved?

Close relationship stressors

    did a close relative suffered a serious illness, injury, or assault?

    did a close family member or friend die?

    you break off a steady relationship?

    did you have a serious problem with a close friend, neighbor, or relative?

General Discrimination

An adapted version of the Daily Life Experiences Scale was used to assess participant experiences of discrimination.[50] The original Daily Life Experiences Scale has 20-items, however the adapted version used 19 of those items. The items how often the survey taker has experienced discrimination (e.g. Being observed or followed in public places). The response scale ranged from 0 to 5: 0= "never," 1= "less than once a year," 2= "a few times a year," 3= "about once a month," 4= "a few times a month," and 5 = "once a week or more." Responses to items were summed to form a total score ranging from 0-95.

Four items from the original scale were also revised, including "Being mistaken for someone else of your same race (who may not look like you at all)" was changed to "mistaken for someone else (who may not look like you at all)" and "Being asked to speak for or represent your entire racial/ethnic group (e.g. What do ___people think?)" was changed to "asked to speak for or represent an entire group (e.g. What do ___people think?), "Overhearing or being told an offensive joke or comment" was changed to "hear an offensive joke or comment" and "Being avoided, others moving away from you physically" was changed to "avoided, or do others move away from you physically." There was also one item added: "Someone in the health system showed you hostility or a lack of respect, refused you service or paid less attention to you compared with others" and one item was omitted "Being considered fascinating or exotic by others."

Items
In general, how often are you ignored, overlooked, or not given service (in a restaurant, store, etc.)?
In general, how often are you treated rudely or disrespectfully?
In general, how often are you accused of something or treated suspiciously?
In general, how often are you do others react to you as if they were afraid or intimidated?
In general, how often are you observed or followed while in public places?
In general, how often are you treated as if you were "stupid", being "talked down to"?
In general, how often are your ideas or opinions minimized, ignored, or devalued?
In general, how often do you hear an offensive joke or comment?
In general, how often are you insulted, called a name, or harassed?
In general, how often do others expect your work to be inferior?
In general, how often are you not taken seriously?
In general, how often are you left out of conversations or activities?
In general, how often are you treated in an "overly" friendly or superficial way?
In general, how often are you avoided, or do others move away from you physically?
In general, how often are you mistaken for someone who serves others (i.e., janitor, bed boy, maid)?
In general, how often are you stared at by strangers?
In general, how often are you laughed at, made fun of, or taunted?
In general, how often are mistaken for someone else (who may not look like you at all)?
In general, how often are you asked to speak for or represent an entire group (e.g., "What do _____ people think?")?
In general, how often has someone in the health system showed you hostility or a lack of respect, refused you service or paid less attention to you compared with others?

Neighborhood Problems

This 15-item scale was adapted from the 13-item Perceived Neighborhood Problems Scale[207] in order to assess the participant's perception of their neighborhood's quality. Two items were added to the original scale: "Feeling unsafe after dark" and "drugs." Participants are asked to respond using the scale: 1 = "Not a problem," 2 = "Minor Problem," and 3 = "Serious Problem."

The 15 items were summed to form a total score.

Items

In your neighborhood, how much of a problem is….
- Vandalism
- Litter and rubbish
- Assault and muggings
- Disturbance by children or youngsters
- Speeding traffic
- Nuisance from dogs
- Reputation of neighborhood
- Smells and fumes
- Burglaries
- Discarded needles and syringes
- Uneven or dangerous pavements
- Lack of safe places for children to play
- Lack of recreational facilities
- Feeling unsafe after dark
- Drugs

Conduct Problems

Conduct problems were assessed by means of an adapted, 7-item version of the DSM Conduct Problems Scale.[209] Participants indicated how often they had various conduct problems in the previous 6 months on a 4-point scale ranging from 1= "5 or more times" to 4= "Not at all." The original DSM Conduct Problems Scale included 17 items and was based on the criteria for a DSM-III-R conduct disorder. The internal consistency of the items in the original scale among a sample of gay/bisexual youth was 0.74.[209] The 7 items were summed to form a total score.

Items

Please mark how often you have done the following in the last 6 months.
Skipped school or work?
Yelled at a friend or family member?
Got into an argument with others?
Got in a fight?
Said things that weren't true?
Stole something?
Been in trouble at school or work?

Depressive Symptoms

Fifteen items were adapted from the 20-item Center for Epidemiologic Studies Depression Scale (CES-D), which was developed by Radloff (1977).[51] The items address whether the participant felt or exhibited the behavior of the major components of depression in the previous week (e.g. I felt that everything I did was an effort). As the original CES-D scale specified, participants were asked to respond using: 0= "rarely or none of the time (less than 1 day)," 1= "some or a little of the time (1-2 days)," 2 = "Occasionally or a moderate amount of the time (3-4 days)," and "Most or all of the time (5-7 days)." The five behavioral manifestations of depression items were removed, including item did not feel like eating, trouble keeping mind on what I was doing, everything I did was an effort, my sleep was restless, and could not get going.

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Items

During the past week…

I was bothered by things that usually don't bother me.
I felt I could not shake off the blues even with help from my family or friends.
I felt that I was just as good as other people.r
I felt depressed.
I felt hopeful about the future. r
I thought my life had been a failure.
I felt fearful.
I was happy. r
I talked less than usual.
I felt lonely.
People were unfriendly.
I enjoyed life. r
I had crying spells.
I felt sad.
I felt that people disliked me.

r=reverse coded

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