

Psychological Science on Pregnancy: Stress Processes, Biopsychosocial Models, and Emerging Research Issues

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preterm birth, low birth weight, pregnancy anxiety, prenatal stress, social support, coping and resilience

Abstract

Psychological science on pregnancy is advancing rapidly. A major focus concerns stress processes in pregnancy and effects on preterm birth and low birth weight. The current evidence points to pregnancy anxiety as a key risk factor in the etiology of preterm birth, and chronic stress and depression in the etiology of low birth weight. Key mediating processes to which these effects are attributed, that is neuroendocrine, inflammatory, and behavioral mechanisms, are examined briefly and research on coping with stress in pregnancy is examined. Evidence regarding social support and birth weight is also reviewed with attention to research gaps regarding mechanisms, partner relationships, and cultural influences. The neurodevelopmental consequences of prenatal stress are highlighted, and resilience resources among pregnant women are conceptualized. Finally, a multilevel theoretical approach for the study of pregnancy anxiety and preterm birth is presented to stimulate future research.

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BACKGROUND

The stereotypical image of the experience of pregnancy is as a happy and joyful time in life when a mother and her partner are expecting a child they planned to have and that they

are well prepared to love and nurture. Most early psychological research on pregnancy actually studied samples that conform to this stereotype—married, middle-class, and affluent women recruited in private health-care settings. The fact, however, is that pregnancy for many women today is an experience characterized by a lack of adequate resources, both socioeconomic and psychosocial, and the presence of many stressors such as work and family responsibilities that make pregnancy a distant reflection of the ideal prototype. Indeed, there is tremendous variability in the experiences of pregnant women as a function of many factors at multiple levels of analysis including an expectant mother’s emotional state, her health and physical condition, where she lives, her socioeconomic status, whether her partner is involved in the pregnancy, and the availability of social support. Thus, one cannot characterize the psychological experiences of pregnancy in any single way for women as a whole. Many of the progressive physiological changes that take place in pregnancy are universal and may generate emotional effects that can make at least the first trimester of pregnancy trying. These changes are well established. Yet the sources of variability in physiology and emotions during pregnancy and in pregnancy outcomes are less well known. Thus, it behooves psychological scientists to consider the major biopsychosocial and sociocultural sources of variation among women and their effects on maternal health and well-being. In addition, the effects of differences in maternal experiences on the developing fetus and infant are beginning to emerge more clearly. A growing body of research over the past decade has established that maternal experiences in pregnancy have extensive effects on the fetus and offspring, which may persist throughout the lifespan.

The purpose of this review is to highlight active areas of research on pregnancy within the domain of psychological science and to point to some emerging themes. In particular, it contains an overview of research on stress processes in pregnancy and the effects on two

birth outcomes, preterm birth (PTB) and low birth weight (LBW), and on the mediating processes to which the effects of stress on these outcomes are most often attributed. It also reviews the role of social processes in pregnancy including social support, partner relationships, and cultural factors, and research on maternal coping. Finally, areas of emerging interdisciplinary science are highlighted wherein psychological research is playing a major role. These are the fetal and neurodevelopment effects of prenatal stress and anxiety, resilience resources in pregnancy, and multilevel analyses of pregnancy and birth outcomes. Due to space limitations, some topics are touched upon only briefly with sparse referencing, but relevant reviews and example research studies are cited that provide some direction for scholarly pursuit.

PTB and LBW are major health problems. Defined as birth before 37 weeks gestation (PTB) and weight at birth of 2,500 grams or less (LBW), these birth outcomes occur in 8% to 12% of all pregnancies worldwide, with strikingly high rates in the United States compared to other industrialized nations (Goldenberg et al. 2008). Moreover, these rates are disproportionately high among some subgroups in the U.S. population; African Americans have roughly twice the rates of most other groups even after controlling for socioeconomic status (SES) and other confounding factors. The potential adverse consequences of PTB and LBW are reviewed elsewhere (e.g., Aarnoudse-Moens et al. 2009, Behrman & Butler-Stith 2006); briefly, these critical indicators of newborn health pose risks of infant mortality, various infant and early childhood health problems, and a range of developmental abnormalities that increase as gestation and birth weight decline. There are many known and hypothesized psychosocial risk factors, and there are considerable psychological consequences for families, both of which bring psychological scientists to the multidisciplinary arena in which these phenomena are now studied.

PSYCHOSOCIAL PROCESSES IN PREGNANCY AND BIRTH: OVERVIEW

A multilevel approach to understanding any health outcome includes individual, social relationship, sociocultural, and community levels of analysis (Dunkel Schetter & Lobel 2010). In the context of pregnancy, relevant individual-level factors influencing birth outcomes are medical (e.g., historical and current medical conditions); genetic; neuroendocrine profiles; behavioral; stress and emotion; and coping behavior, styles, and resources. Relationship-level analyses include social network, social support, partner relationship, family, and intergenerational influences. Sociocultural-level analyses include race/ethnicity, nativity, acculturation, SES, and cultural norms and values. Community-level factors include the physical environment, characteristics of neighborhoods, health-care access and quality, and related geographical factors. Each of these has received attention in past research on pregnancy, with a stronger emphasis historically on medical and behavioral risk, and recent emphasis on sociocultural and community factors. The focus here is on several of these factors at more than one level centering around the key concept of stress. Research on stress and emotions in pregnancy has been growing rapidly for two decades and is a timely topic for consideration.

STRESS PROCESSES IN PREGNANCY AND BIRTH

The study of stress in pregnancy became of interest because many other approaches to the prediction of adverse birth outcomes did not adequately identify which women would deliver their infants early or have babies that were too small for their gestation (Lu & Halfon 2003). Some of the stressors that may affect women in pregnancy are financial problems, strain in intimate relationships, family responsibilities, employment conditions, and pregnancy-related concerns. Despite major challenges in

Birth outcomes:

refers to medically defined and clinically significant birth endpoints including low birth weight and preterm birth

Preterm birth

(PTB): birth before 37 weeks gestation due to early labor, early rupture of fetal membranes, induced labor, or elective surgical delivery

Low birth weight

(LBW): weight of an infant at birth of less than or equal to 2,500 grams

SES: socioeconomic status

Gestational age/gestational length (GA/GL): number of weeks gestation at birth, determined from calculating the date of conception by ultrasound and by last menstrual period; 40 weeks is a full gestational length

defining and measuring stress (Cohen et al. 1995), methodological issues involving study designs and samples, and lack of strong theoretical models, there now exists a strong body of research documenting the important contributions of stress and emotions in pregnancy to specific outcomes during pregnancy and birth.

Stress and Preterm Birth

Dunkel Schetter & Glynn (2010) provide a systematic review of the strongest evidence on stress and PTB organized by type of stress. More than 80 investigations were reviewed, of which a majority had prospective designs, larger samples, and validated measures. Of the 14 published studies assessing major life events in pregnancy, nine reported significant effects on when a baby is born [PTB or gestational age/gestational length (GA/GL)]. Women who experienced major life events such as the death of a family member were at 1.4 to 1.8 times greater risk of PTB. A second, smaller group of studies is on catastrophic community-wide disasters such as earthquakes or terrorist attacks. Two-thirds of these (six of nine) showed significant effects on GA/GL or PTB. A third topic of research is on chronic stress, including studies on general strain, household strain, and length and severity of homelessness. In all five of these studies, chronic stress predicted PTB. Finally, a majority of the investigations on neighborhood stressors such as poverty and crime (seven of eight) also indicated significant effects on GA/GL or PTB.

In comparison, none of four studies on daily hassles measured with standard scales had significant effects on birth outcomes, although none used diary methodologies that would provide the most accurate information. Fewer than half of the studies using standard scale measures of perceived stress found significant effects on PTB or GA/GL (5 of 11 studies). Using perceived stress measures in combination with other stress measures, however, predicted PTB in some of these studies (Lobel et al. 1992, 2008; Zambrana et al. 1999). For example, in a study of 927 low-income pregnant women of

Mexican origin or descent who were giving birth for the first time and who were interviewed in the second trimester, women with high-stress composite scores (perceived stress, state anxiety, and life events) had more than 2.5 times the risk of PTB (OR = 2.70, CI 1.23, 5.93) compared to low-stress women when controlling for age, acculturation, and medical risk (Dunkel Schetter et al. 2010a, Zambrana et al. 1997),

In summary, stress exposures such as life events, major catastrophes, chronic strain, neighborhood stress, and multiple stressors appear to contribute independently to the risk of PTB. However, the precise forms of stress that are most potent are not easy to identify from the studies described. In contrast to the studies of stressful exposures, only 3 of 14 studies on depressed mood or symptoms of trauma indicate effects on or PTB. Thus, evidence points to major stressors and not depression as a primary risk factor for PTB.

State anxiety and pregnancy anxiety. State anxiety has been significantly related to GA/GL or PTB in 7 out of 11 studies, but only in combination with other measures or in subgroups of the sample (e.g., Catov et al. 2009). Roesch et al. (2004) used multidimensional modeling techniques to untangle the effects of state anxiety, pregnancy anxiety, and perceived stress on GA, each measured at three different times in pregnancy. All three forms of stress predicted timing of birth, controlling for medical and demographic risk factors, but pregnancy anxiety was the only significant predictor when all three were tested in the same model. Pregnancy anxiety assessed by only four adjectives (feeling anxious, concerned, afraid, or panicky about the pregnancy) as early as 18 weeks in pregnancy predicted when the baby was born.

In fact, there is surprisingly convergent evidence across studies of diverse populations regarding the adverse effects of pregnancy anxiety on PTB (Dunkel Schetter 2009, Dunkel Schetter & Glynn 2010). Pregnancy anxiety is a distinct syndrome (Huizink et al. 2004), defined here as fears about the health and well-being of

one's baby, the impending childbirth, of hospital and health-care experiences (including one's own health and survival in pregnancy), birth and postpartum, and of parenting or the maternal role. It represents a particular emotional state akin to state anxiety but more contextually based in that it is specifically rooted in concerns among pregnant women about their pregnancy. Ten or more prospective studies have been conducted on pregnancy anxiety, all of which report significant effects on the timing of birth. Many of these are programmatic studies conducted over the past 15 years (e.g., Rini et al. 1999, Roesch et al. 2004, Wadhwa et al. 1993). For example, pregnancy anxiety was assessed with a 10-item scale that reflected anxiety about the baby's growth, loss of the baby, and harm during delivery, and a few reverse-coded items concerning confidence in having a normal childbirth (Rini et al. 1999). These items in combination with state anxiety formed a latent prenatal anxiety factor that predicted GA/GL controlling for medical risk factors, ethnicity (Latina or white), education, and income. Of note, these results were also independent of the effects of several individual differences (mastery, self-esteem, and optimism).

Three large, well-controlled, prospective studies in different geographical regions have replicated these results using some of the same pregnancy anxiety measures. One investigation in North Carolina found that pregnancy-related anxiety in mid-pregnancy predicted spontaneous PTB in a sample of nearly 2,000 pregnant women (58% white and 36% African American) controlling for a wide range of confounding variables (Dole et al. 2003). A second study of 1,820 women in Baltimore (two-thirds of whom were African American) also found that high pregnancy anxiety significantly increased the risk of PTB (Orr et al. 2007; see also Catov et al. 2009). The most recent study involved 4,885 births over five years in Montreal, of which 207 were preterm (Kramer et al. 2009). Extensive measures of stress and related psychosocial factors were completed mid-pregnancy. Only pregnancy anxiety, however, predicted spontaneous PTB;

women with high pregnancy anxiety were 1.5 times at greater risk of an early delivery, controlling for sociodemographic covariates and medical and obstetric risks. Effects persisted after perceptions of pregnancy risk were controlled, which addresses the issue of confounding of pregnancy anxiety with realistic worries over high-risk pregnancies.

This evidence is unusually conclusive indicating that pregnancy anxiety (PrA) predicts the timing of delivery seemingly in a linear manner; further, it predicts risk of spontaneous PTB, with meaningful effect sizes across studies that are comparable to or larger than effects of known risk factors such as smoking and medical risk. Furthermore, these effects hold for diverse ethnic groups, including large samples of African Americans, Hispanics, and whites. The consistency of these findings paves the way for investigating the antecedents and correlates of PrA, mechanisms of effects, and available treatments.

Stress and Low Birth Weight

A second area of developing convergence concerns effects of stress on infant birth weight. Infants born preterm are often of LBW. However, birth weight is also determined by the rate of fetal growth, meaning that infants carried to term can also be born with LBW. It has been estimated that two-thirds of LBW infants are born preterm. Past studies of fetal growth, fetal or intrauterine growth retardation (IUGR), and birth weight as they relate to psychological factors point to the role of maternal depressive symptoms (Field et al. 2006). Dunkel Schetter & Lobel (2010) reviewed the strongest available research on possible influences of maternal stress and emotion on fetal growth and birth weight and concluded that the evidence is most consistent regarding the effects of maternal depressive symptoms and general distress during pregnancy on reduced infant birth weight. All seven studies reviewed showed relatively large effects of maternal depressive symptoms or mood on infant birth weight—up to four times the risk

Pregnancy anxiety (PrA): anxiety during pregnancy that pertains to the pregnancy, birth, and subsequent parenting

compared to infants born to nondepressed women. The largest effects occurred among low-income or low-social-status women and women of color, suggesting interactions of depressed mood with SES, race, and ethnicity.

A pertinent question is whether these effects of depression on birth weight are attributable mainly to pregnant women who have depressive disorders having higher risk of adverse outcomes or whether they reflect a dose-response effect of depressive symptomatology on birth weight. Most studies either exclude women with psychiatric disorders or have very low rates of them in the sample, but a few studies and reviews (Alder et al. 2007, Ross & McLean 2006) address this issue. In a population-based retrospective cohort study of more than half a million births in California using hospital discharge data, psychiatric diagnoses predicted LBW adjusted for marital status, ethnicity, and adequacy of prenatal care (Kelly et al. 2002), but the study did not disaggregate by type of disorder. In a second study of 1,100 women who were screened for psychiatric disorders during pregnancy (Rogal et al. 2007), mothers with a depressive disorder had significantly higher risk of giving birth to a LBW infant (OR = 1.82). However, a third population-based study of 1,465 Swedish women with depressive and anxiety disorders during the second trimester found no differences in birth outcomes compared to healthy women (Andersson et al. 2003). Thus, at present, it appears that LBW may be more common in women with psychopathology, which is consistent with the other evidence on depressed mood and LBW. However, existing studies need follow-up with attention to the type and severity of mood disorder, distinctions between symptoms of depression and symptoms of pregnancy, and attention to psychiatric medication use. In population studies, the full range of depressive symptoms should be examined to determine whether effects on birth outcomes are linear. Future studies can address some of these pertinent questions and can inform efforts to screen pregnant women in prenatal care for mood disorders.

Chronic stressors are also robust predictors of birth weight (Dunkel Schetter & Lobel 2010, Rich-Edwards & Grizzard 2005). For example, chronic stressors such as unemployment and crowding predicted 2 to 3.8 times the risk of LBW among 1,363 pregnant low-income women in the Midwest (Borders et al. 2007). One source of chronic stress and strain is perceived racism and discrimination, not only during the pregnancy itself but also prior to it, and not only from personal exposures but also vicarious exposures in addition to personal exposures (Parker-Dominguez et al. 2005). All of eight studies available on racism demonstrated that race-related stressors prospectively predicted birth weight, especially in African American women (reviews in Dunkel Schetter & Lobel 2010, Giscombe & Lobel 2005). Thus, depression, chronic strain, and racism are important to study further, considering their apparent role in the etiology of LBW. However, future studies must examine them in combination because they are likely to be highly confounded. Investigations of chronic stress and racism do not usually control for depressive symptoms, yet depression may be an important mechanism whereby the effects of exposure to chronic stress and racism influence fetal growth and birth weight, likely to occur via downstream physiological and behavioral mechanisms, as discussed below.

Mediating Processes: X-Y-Z

Psychological science on stress, health, and disease in general currently emphasizes mechanisms underlying relationships between psychosocial variables and health outcomes (Miller et al. 2009). Some researchers have used a simple heuristic to label mechanisms (Y) linking a psychosocial factor (X) with a health outcome (Z) (Kemeny 2003a,b). Regarding the links between prenatal stress (X) and birth outcomes (Z), considerable attention has focused on the Y component in both animal and human research paradigms. The primary hypothesized biopsychosocial mechanisms of both PTB and LBW are neuroendocrine,

inflammatory/immune, and behavioral (Hobel et al. 2008). A smaller subset of PTBs is attributed to vascular factors (see Dunkel Schetter & Glynn 2010); notably, vascular factors are particularly important in fetal growth. The majority of research has been on the first two physiological mechanisms on PTB. In comparison, considerably less biopsychosocial research has been conducted on the mechanisms linking stress and LBW. It has been thought that stress may be associated with lack of oxygen to the fetus (hypoxia), adversely affecting fetal growth, a topic worth further attention.

Neuroendocrine-mediating processes. Up to one-quarter of preterm births are attributed to the influence of stress on neuroendocrine mechanisms. It has been hypothesized that a key pathway from stress to PTB involves activation of the hypothalamic-pituitary-adrenal (HPA) axis of the mother as a result of maternal stressors. Evidence consistent with this hypothesis is reviewed elsewhere (Behrman & Stith-Butler 2006, Dunkel Schetter & Glynn 2010, Sandman et al. 1997). Illuminating research with sheep and other species has shown that the maternal HPA axis is progressively activated in normal pregnancy and is instrumental in the onset of normal labor. Further, the exponentially increasing release of corticotropin-releasing hormone (CRH) from the placenta (pCRH) plays a central role in initiating a cascade of effects leading to labor, which has been referred to as the placental clock (Smith 1999, Smith et al. 2009). Human research points to maternal HPA activation and early pregnancy rises in pCRH in response to maternal stress or negative affect as pathways to PTB (Hobel et al. 1999, Sandman et al. 2006, Wadhwa et al. 1996). However, only a few human studies provide evidence of mediation of the effects of maternal stress or negative affect on earlier delivery via pCRH. For example, there is some evidence that pregnancy anxiety or concern about the pregnancy may be associated with changes in HPA function (McCool et al. 1994, Obel et al. 2005) that mediate effects on early birth (Mancuso et al.

2004). These mechanisms are extraordinarily complex and difficult to study, and they remain under active investigation and scrutiny. For example, CRH assays are difficult to do and expensive. In addition, ethnic and racial differences in HPA activity in pregnancy appear to exist (Glynn et al. 2007, Suglia et al. 2010). Although the bulk of work has been on HPA involvement in PTB, some evidence is consistent with HPA involvement in fetal growth and LBW (e.g., Diego et al. 2006, Field et al. 2006). For example, a study of stress hormones in maternal blood at 15, 19, 25, and 31 weeks gestation showed effects on fetal neurodevelopmental maturation independent of gestational length (Ellman et al. 2008).

Inflammatory and immune-mediating processes. As is well known, human neuroendocrine and immune processes are integrally related. A majority of PTBs have been attributed to inflammatory pathways (Goldenberg et al. 2000). Inflammation is a process by which tissues respond to various insults through upregulation of chemokines, cytokines, and other complex responses. During pregnancy, the balance of particular types of cytokines (Th2, Th1) shifts over the course of gestation, and when abnormal, may initiate and intensify the amount of proinflammatory cytokine production. These processes are detailed in full elsewhere (Challis et al. 2009). Maternal and placental hormones affect these inflammatory pathways.

Infections of the reproductive and urinary tracts, sexually transmitted diseases, systemic infections, and even periodontal disease in mothers pose risk of PTB. Stress is a well-known contributor to inflammation in general (Cohen & Herbert 1996). In pregnancy, this is an active area of inquiry (reviews in Coussons-Read 2003, Coussons-Read et al. 2003, Wadhwa et al. 2001). However, definitive studies linking stress, inflammation, and PTB have not been published. High levels of prenatal stress have been associated with elevated proinflammatory cytokines and C-reactive protein (Coussons-Read et al. 2003, 2005, 2007).

Hypothalamic-pituitary-adrenal (HPA) axis: one of two basic biological systems involved in the classic stress response, a response to stress with various hormones that are responsible for preparing the body to fight or flee

Corticotropin-releasing hormone (CRH): a peptide that is one of the key components in the stress response. CRH is released by the hypothalamus in response to stressful stimuli, which activates a cascade of other hormonal releases from the pituitary and adrenal glands. During pregnancy, it is released by the placenta and is thought to play an important role in the timing of onset of parturition

Small for gestational age (SGA): infant with birth weight that is low relative to length of gestation or gestational age compared to population-based statistical data (below the tenth percentile)

Furthermore, high levels of chronic stress at both the individual and community levels have been linked to vaginal bacterial infections, which are a risk factor for PTB (Dunkel Schetter & Glynn 2010). These findings provide preliminary support for the hypothesis that the effects of prenatal stress on birth outcomes are partially mediated by inflammatory processes, but there is much we do not yet understand about how these mechanisms work and for whom they are most pertinent. For example, genetic variation in anti-inflammatory cytokines has been found to influence risk of PTB and possibly risk of having an infant that is small for gestational length (Engel et al. 2005), and research on polymorphisms in genes related to infection-mediated preterm birth is relevant (Krediet et al. 2007). Further detail on this important set of mechanisms and their role in intrauterine growth retardation as well as preterm birth is beyond the scope of this review but remains a plausible, though complicated, link between stress and adverse outcomes.

Behavioral mediating processes. The behavioral pathways to adverse birth outcomes involve the usual suspects that constitute healthy or unhealthy lifestyles, such as smoking, substance use, diet, and physical activity. Smoking and substance use (especially cocaine) are implicated in PTB (Savitz & Dunkel Schetter 2006), and inadequate nutrition and tobacco use are clear risk factors for LBW (see Dunkel Schetter & Lobel 2010). There is some evidence regarding physical strain or excess physical activity as well (reviewed in Dunkel Schetter & Lobel 2010, Woo 1997). Exercise for fitness within reason does not appear to pose risk (Kramer & McDonald 2009), but physical exertion experienced in physically demanding work activities has been found to increase risk of preeclampsia (hypertension in pregnancy), small for gestational age (SGA), and PTB in one meta-analysis (Mozurkewich et al. 2000).

In addition, there is ample evidence that stress is associated with poorer health behaviors during pregnancy (Dunkel Schetter & Lobel 2010). As with the physiological mech-

anisms to adverse birth outcomes, however, there is little evidence for the full X-Y-Z pathway concerning behavioral mechanisms, with a few notable exceptions. One exception is a study in which the impact of pregnancy-specific stress on birth weight was explained in part by its association with cigarette smoking (Lobel et al. 2008). An ethnically diverse sample of 279 women was interviewed about various types of stress and health behaviors three times in pregnancy. Those who were experiencing the greatest pregnancy-specific distress were more likely to smoke cigarettes during pregnancy and as a result to deliver a LBW infant. Related results were obtained in a cohort of more than 900 low-income Mexican-origin women giving birth for the first time (mentioned above). In this study, greater risk of PTB due to high stress was no longer statistically significant when alcohol and substance use were controlled in analyses, suggesting that poor health behaviors mediated the stress/PTB effects in that sample (Dunkel Schetter et al. 2010a).

A thorough understanding of health behaviors in pregnancy requires attention to a range of motivational processes such as intention, beliefs, and self-efficacy, as well as behavior, topics that psychological science has advanced greatly (DiClemente 1993, Fishbein et al. 2001, Leventhal et al. 2007, Schwarzer 2001). Consuming a healthy diet, taking prenatal vitamins, and refraining from smoking and use of alcohol or substances are recommended for all pregnant women. Observational and intervention research on prenatal health behaviors stands to benefit from greater collaboration with psychological scientists.

Differentiating Predictive Models of PTB and LBW

Interdisciplinary science has had a tendency to lump many distinguishable psychological processes into one amorphous category of “psychosocial factors” that typically includes stress, various emotions, coping, individual differences, social support, and more. Sophisticated multilevel analyses, however, must distinguish

among distinct components within psychological processes in order to examine them meaningfully in pregnancy. What is intriguing in the extensive bodies of research on stress and these two objective birth outcomes—when a child is born and how much he or she weighs—is that the psychological processes involved in their etiologies are becoming more distinct. As indicated above, PrA appears to be the strongest predictor of the GA/GL and PTB, whereas depression and chronic strain appear to be stronger predictors of birth weight and LBW. This implies that the psychological processes involved in these related yet distinguishable birth outcomes can be differentiated. The etiology of early delivery is not identical to that of reduced fetal growth, although there are some common elements (McElrath et al. 2008). Similarly, the psychological pathways contributing to these two birth outcomes deserve individual attention, which opens up the way for more sophisticated psychological mechanistic models. Most of the relevant processes are already well researched in psychology, providing a strong scientific base for application to research on pregnancy. Further discussion on the multilevel prediction of birth outcomes is provided below, after sections on coping processes and social processes in pregnancy.

Coping Processes in Pregnancy

An open area of opportunity is the study of coping in pregnancy. One direction for future research may be to consider the ways women cope with anxiety during pregnancy and to help them increase their skills in such areas as relaxation and seeking effective support. Lobel and associates have begun to build knowledge of how pregnant women manage stress in pregnancy and the consequences (Lobel et al. 2008; Yali & Lobel 1999, 2002). Generally defined as cognitive and behavioral efforts to manage stressful demands, coping may act directly on birth outcomes, as a modifier of stress effects, or to minimize or prevent the occurrence of stress. Existing studies of coping in pregnancy have tested mainly the associations of coping with levels of

prenatal stress or distress and rarely in longitudinal designs (cf. Da Costa et al. 2000). For example, in one of the better studies, emotion-focused and problem-focused coping were associated with lower distress in early and mid pregnancy among low-risk women having a first child (Huizink et al. 2002).

Although there have been many descriptive studies on coping in pregnancy, very few exist on birth outcomes. One large retrospective study of low-income pregnant women reported that those with “poor coping skills” were at higher risk of LBW after adjustments for age and other factors (Borders et al. 2007). However, the measure of coping skills used in this study was designed to assess something else (i.e., hope), which raises questions about the meaning of the results. In the only large prospective study of coping and birth outcomes, African American women ($N = 724$) were at slightly higher risk of PTB when they were high in distancing as a coping style in pregnancy (Dole et al. 2004; see also Messer et al. 2005). Distancing involved minimizing stress or detaching from it. Thus, further study on mothers’ coping mechanisms during pregnancy and effects on outcomes seems warranted.

However, a barrier to progress on this topic is that past studies have conceptualized coping in pregnancy interchangeably as both behavior and traits or dispositions and have used many different approaches to measurement. For example, most studies examined how pregnant women say they cope in general, presumably meaning prepregnancy, or researchers study coping “during pregnancy” nonspecifically, not coping with any specific pregnancy stressors or in any specific time frame. If we are to study the coping behaviors of pregnant women, however, the challenge is to determine the sources of stress with which women are coping in a particular sample. Lazarus & Folkman (1984), whose theory dominates research on coping, were adamant that the study of coping behavior must take place within the context of a specific stressful situation and its appraisal. Thus, studies of stress in pregnancy might approach the topic by determining for a given sample or

individual within the sample what the pressing demands are, how they are appraised, and how they are managed (cf. Cote-Arsenault 2007). Given the limitations of coping scales, this may call for diary studies of high-stress pregnant samples using state-of-the-art ecological momentary assessment approaches.

Before investing time and funding, however, it would be useful to develop stronger theory and hypotheses regarding the effects of coping in pregnancy on outcomes. Many researchers working on this topic do not even have a priori hypotheses. For example, it can be hypothesized that emotion regulation in pregnancy influences maternal affect and indirectly affects birth outcomes. However, methods of emotion regulation used by high-risk pregnant women may or may not fit existing theories and methods on emotion regulation in psychological science. It may be necessary to engage in exploratory work to determine what methods pregnant women of low SES and particular ethnicities use to manage stress in their lives and what works or does not work for them. Abdou et al. (2010b) collected qualitative data on coping with stress in a small sample of predominantly women of color recruited in public-health clinics serving low-SES women. To manage stress, these women reported spending time with “the girls,” venting emotions and laughing, which provided much needed tension release and distraction from their problems. Women also reported a strong reliance on spiritual and/or religious beliefs for comfort and guidance. These are methods of coping that may not be adequately captured in existing pregnancy research tools. Qualitative approaches such as this for understanding coping in various racial, ethnic, and low-SES populations may yield useful direction on the role of coping in pregnancy and birth outcomes. In addition, it can address the appropriateness of existing stress management interventions, such as meditation and cognitive behavioral techniques, for improving outcomes in specific subgroups.

Related issues involve the study of coping dispositions or traits in pregnant women, for

instance, stable tendencies to express or to repress emotions, to problem solve or to avoid engaging with a stress, and to seek support or to be self-reliant. These sorts of dispositions that predate pregnancy as means of managing chronic stress deserve investigation. Researchers can utilize existing measures of coping skills, such as the ability to relax or to express feelings, and process them to see if these skills are beneficial in pregnancy (Robbins & Dunkel Schetter 2010, Stanton 2010). The advantage of this sort of focused approach to the study of coping is that specific coping skills are quite susceptible to intervention with known methods of coping and stress management instruction, such as those developed for HIV and cancer (e.g., Antoni & Smith 2003). Further study of coping skills in pregnancy seems advisable, especially if it is undertaken with strong theoretical premises and measures.

SOCIOCULTURAL PROCESSES IN PREGNANCY

Pregnancy is a perfect time in the lives of women to study personal relationships and broader social processes. Particularly if it is a first pregnancy, family and friends are often involved in celebrating the birth and supporting the woman, although as noted above, this varies depending on the woman’s circumstances. Depending on the cultural and socioeconomic contexts, extended family members may live with the pregnant woman or close by and may have important roles in an expectant mother’s life. Thus, pregnancy offers an opportunity to study diverse social circumstances, relationships, and relationship quality and provides a unique window for studying the marital or partner relationship in detail. Psychological research on pregnancy to date has not fully capitalized on this rich set of opportunities. The primary focus has been on social support, thought broadly to be a major factor in promoting healthy pregnancies and buffering effects of stress. As a result of poor conceptualization, diverse measures, and limitations in study designs, however, social

support has not been consistently linked to birth outcomes, with some notable exceptions.

Prospective Observational Research on Social Support in Pregnancy

There is a small body of observational studies on the effects of social relationships and social support on birth outcomes, but very few are large prospective investigations with strong measures and appropriate controls. Consequently, the results are inconsistent (see reviews by Blondel 1998; Dunkel Schetter et al. 1996, 2000; Hoffman & Hatch 1996; Sagrestano et al. 1999). Some show effects of inadequate prenatal social support on shorter GA/GL or PTB (e.g., Norbeck & Anderson 1989), but most report that greater prenatal support predicts more optimal fetal growth, higher birth weight, or lower risk of LBW (e.g., Hedegaard et al. 1996, Mutale et al. 1991). For example, using a case-control design, New Zealand researchers compared formal and informal sources of support available during pregnancy to mothers of 836 infants that were born small (SGA) with that available to 870 normal-weight controls (Pryor et al. 2003). Lack of social support, especially family support, and low involvement in social groups among mothers were significantly associated with having SGA infants. Consistent results emerged from a Swedish study that assessed social resources (defined as social stability, social participation, and support) in 826 pregnant women giving birth for the first time (Dejin-Karlsson et al. 2000). They found that lack of social resources increased the risk of having infants that were SGA.

In another observational study of 247 Latina and white pregnant women, prenatal social support measured early in the third trimester significantly predicted greater birth weight adjusted for length of gestation (Feldman et al. 2000). Social support mediated the effects of being married on birth weight, with 31% of the total variance predicted after controlling for ethnicity, education, obstetric risk, and sex of infant in the model. This study is unique in a number of ways. It is the only published study

that assessed support with three standardized scales (with a total of 55 questions) and that measured support from both baby's father and family, as well as both available and received support. It is also among the few to utilize structural equation modeling to create a latent support factor (cf. Collins et al. 1993).

Campos et al. (2008) more closely attended to ethnic and cultural factors within a sample from the same geographical region composed of 68 U.S.-born Latinas, 31 foreign-born Latinas, and 166 European American women. All were interviewed in the second trimester, and measures of social support and the cultural construct of familism were obtained. Familism refers to a Latino cultural script entailing identification with family, obligation to family, and social support from family (Sabogal et al. 1987, Steidel & Contreras 2003). In this study, prenatal social support predicted higher infant birth weight among the foreign-born Latinas only. These results were accounted for by stronger associations of birth weight with affectionate support and positive social interactions (both subscales of the validated 19-item social support scale) among the foreign-born Latinas. Thus, the results of this study substantiate that social relationships and sociocultural context together are important in understanding maternal health and well-being in pregnancy.

The effects of social support in these and other studies are typically stronger in subgroups of the sample, especially within specific ethnic groups. Analyses of archival data, for example, of more than 8,000 births in Chicago (Buka et al. 2003), revealed significant effects of perceived neighborhood social support on birth weight in white mothers only, but not among African Americans. In contrast, Norbeck & Anderson (1989) found effects of social support on BW only for African Americans, not for white and Hispanic women, and these effects were only for social support from partner or mother. Thus, the pattern of results across studies suggests that maternal race and ethnicity, cultural values, and the specific type of support are important moderators of effects on birth weight. Exactly which types and sources of

support are relevant for each subgroup remains to be fully understood.

Partner Relationship Research in Pregnancy

Regarding the relationship between a pregnant woman and her partner, there is very little systematic research. Some authors comment on the central importance of the father and the relationship between parents (Hoffman & Hatch 1996), but few have investigated this topic in depth. An interesting approach involved asking the partners of 68 pregnant inner-city women to estimate the level of stress of their wives or partners. Women who had more life events had greater depression if their partners underestimated their stress levels (Chapman et al. 1997). In another study (Dunkel Schetter et al. 2010b, Rini et al. 2006), women's prenatal reports of the extent to which the quality and quantity of partner support met their needs (conceptualized as "social support effectiveness") prospectively predicted lower anxiety in mid-pregnancy and reduced anxiety and depressive symptoms from pregnancy to postpartum. Furthermore, mothers' perceptions of the quality, intimacy, and equity of the partner relationship predicted their perceptions of effective support from the partner. Overall, relationship quality and effectiveness of partner support appear to be closely and reciprocally associated, each having independent implications for maternal well-being. These findings were based on detailed interviews with several hundred pregnant women, supplemented by interviews with a small sample of 23 of the partners. All of the women were married, cohabiting, or planning to marry. Partner support was appraised as more effective by both pregnant women and their partners when partners were more skilled and more motivated to be caregivers or support providers (Rini & Dunkel Schetter 2010). These results provide new insights into relationship processes in pregnancy and affirm the benefits of a strong relationship and social support from a woman's partner to subsequent maternal well-being.

Social Support as a Moderator of Stress and Birth Outcome Effects

Most of the prenatal observational research on social support has tested only for main effects on birth outcomes, although the dominant hypothesis in the pregnancy literature is that support interacts with stress. Stated as the "buffering hypothesis," this argument is that social support buffers the effects of stress on birth outcomes for pregnant women, yet very little evidence of this exists (Norbeck & Tilden 1983). One of the better studies on this topic (Turner et al. 1990) found evidence of support buffering or moderation in a prospective study of 268 pregnant teenagers. Social support interacted with stress in effects on BW, but only in the low-SES group.

A subsequent study examined the role of social support in detail and found both direct effects and interactions of support and stress on BW (Collins et al. 1993). Among women who experienced high numbers of life events during pregnancy, those with better-quality social support delivered infants with higher birth weight; this effect was not significant for women who had low levels of life events. Whereas support quality was the only type of social support that had an interactive effect with stress, other aspects of support, such as the availability of a social network, were directly associated with pregnancy outcomes in this study. These findings highlight again the importance of studying different dimensions of social support (e.g., quantity, quality, and network) as well as different sources (e.g., partner, family).

In sum, observational research has provided a sufficient basis for researchers to maintain the hypothesis that social support is beneficial in pregnancy. Although this body of research is neither extensive nor consistent, results from investigations with greater conceptualization and rigor suggest that some types of support appear to benefit some subgroups of mothers in terms of fetal growth and resulting BW. These effects appear to be mostly direct effects, not interactions with stress. However, many investigations have not adequately conceptualized

or measured prenatal stress and social support in sufficiently large samples to test moderation. In addition, consideration of the role of racial, cultural, and ethnic factors related to social support processes has been underemphasized, and attention to these factors would improve our understanding substantially.

Intervention Research on Social Support in Pregnancy

Social support intervention studies in pregnancy that could provide further evidence, especially regarding causality, have not been very elucidating. Most have not demonstrated effects of support on birth weight or on any birth outcome (see reviews by Blondel 1998, Lu et al. 2005, Stevens-Simon & Orleans 1999). A Cochrane review of 16 randomized controlled trials involving more than 10,000 pregnant women (Hodnett & Fredericks 2003) concluded that “additional support did not reduce the likelihood of giving birth early or that the baby was smaller than expected.” These and other reviews discuss the theoretical and methodological problems in the intervention work on social support in pregnancy (e.g., Sagrestano et al. 1999). This literature can be characterized as atheoretical on the whole; accordingly, interventions are not guided by predictive models nor do they isolate supportive elements of the treatment from other elements such as education aimed at health behavior change. For example, one powerful experimental investigation of a group-focused program of prenatal care that included education and social support through facilitated group discussion found that women who participated in the program were 33% less likely to deliver preterm (no effect on LBW) compared to control women receiving conventional prenatal care (Ickovics et al. 2007). However, it is not clear whether the education, the social support components, or the combination were the potent mechanisms.

Another problematic aspect of many studies is who is selected as the target group for the in-

tervention. Many prenatal support intervention studies have targeted sociodemographic subgroups such as poor or ethnic minority women or women with high-risk medical conditions. It is often unclear, though, whether the targeted group was highly stressed or low in social support; therefore, the lack of effects of the social support intervention does not speak to the effects of support provision for stressed or unsupported women in pregnancy. A notable study by Norbeck et al. (1996) is an exception: Low-income African American women ($N = 114$) were identified from a larger group as lacking support in mid-pregnancy, and the treatment involved enhancing social support through in-person sessions and telephone contact, showing an effective reduction in LBW from 22% in the control group to 9% in the intervention group.

Two recent reviews of social support interventions in pregnancy (Hodnett & Fredericks 2003, Lu et al. 2005) conclude that although there is little evidence of benefits of support interventions in pregnancy to date, theory-driven and rigorous interventions are still worthwhile. Specifically, future intervention studies must be designed in conjunction with evidence-based predictive models and must identify risk groups effectively, match interventions to risk factors, and test process variables or theoretical mechanisms. Although the mechanisms of social support influences on health in general have been explicated (e.g., Cohen 1988), those explaining effects of support on birth weight have not been analyzed. A premise in the literature is that support in the form of information or education about healthy pregnancy may influence pregnant women to adopt healthier behaviors. Tangible assistance in the form of shopping, cooking, or providing transportation may also influence health behaviors such as healthy eating and prenatal care. Emotional support in various forms may operate differently to influence birth outcomes via reduced anxiety and physiological arousal. If further prenatal support intervention research is to be undertaken, explication of the mediating mechanisms hypothesized to produce any effects is essential.

Cultural Factors and Relationships Processes in Pregnancy

A related topic is the extent to which a woman and her culture place particular significance on the importance of having children and maintaining close proximity to family of origin. As noted above, Campos et al. (2008) found that familism together with social support was an important predictor of birth weight in foreign-born Latinas who also had higher mean scores on familism than European American pregnant women. In an earlier investigation, culturally relevant items regarding how much a woman felt special, lucky, and healthy during pregnancy were higher on average in Mexican immigrants than in Mexican Americans, and higher in both Mexican groups than in African Americans. Moreover, these items formed an index of positive attitudes toward pregnancy that mediated group differences in birth weight. That is, the lower birth weights of African American women were partially explained by less favorable attitudes toward the specific pregnancy compared to women of Mexican origin and descent (Zambrana et al. 1997).

One valuable direction is to develop cultural approaches that can be used across ethnic groups rather than in single ethnic or racial groups. Accordingly, Abdou et al. (2010a) operationalized “communalism,” a cultural value emphasizing family and interdependence, using a combination of established measures in a sample of nearly 300 African American and non-Hispanic white pregnant women. Communalism was a more robust predictor of prenatal emotional health than ethnicity, childhood, or adult SES, and communalism interacted with ethnicity and SES in effects on blood pressure. African American women and women with lifetime socioeconomic disadvantage who were low in communalism had higher blood pressure during pregnancy compared to African American and low-SES women with high communalism. The effects of communalism on prenatal affect, stress, and physiology were not explained by a number of possible confounds including depressive symptoms, available

support, self-esteem, optimism, mastery, or attitude toward pregnancy. These findings suggest that a communal cultural orientation benefits maternal emotional well-being and physiology over and above its links to other personal and social resources. They also affirm the value of detailed cultural analyses in the study of pregnancy within a broader multilevel approach to understanding birth outcomes.

FRONTIERS IN PSYCHOLOGICAL SCIENCE ON PREGNANCY

Fetal Programming and Developmental Effects

It is difficult to write about pregnancy and birth at this time without making reference to the enormous interest in the topic of “fetal programming.” This term refers broadly to the effects of maternal environmental influences during pregnancy on the development of the fetus, the infant, and the offspring’s health throughout the lifespan. That life in the womb sets the stage for health and well-being across the lifespan is a profoundly important premise that has reverberated throughout scientific disciplines, generating tremendous interest (see Beydoun & Saffas 2008, DiPietro 2004). Also referred to as the “Barker hypothesis” because it is attributed to a British physician of that name, the original premise is that fetal undernutrition permanently changes the organism’s body structure, physiology, and metabolism, leading to coronary heart disease and stroke in later life. There is considerable evidence in support of this original hypothesis, more aptly called the fetal origins hypothesis (for review, see Barker 1998, Bergman et al. 2007, Cottrell & Seckl 2009, Phillips 2004).

Although the study of psychological factors in pregnancy and effects on mother and infant had sufficient impetus before the advent of research on fetal programming, it has certainly been fueled further by this development. Researchers in many fields are working aggressively to understand the multilevel influences on the fetus, including the role of maternal

psychological stress, in order to understand in what ways and how far into the future these influences extend. Animal models with rodents and nonhuman primates indicate that maternal distress negatively influences long-term learning, motor development, and behavior in offspring (DiPietro et al. 2002; review by Schneider & Moore 2000). Evidence suggests that this occurs via effects on development of the fetal nervous system and alterations in functioning of the HPA axis (Coe & Lubach 2008, O'Connor et al. 2005, Schneider & Moore 2000), some of which may be adaptive (DiPietro et al. 2010, Parker et al. 2006). Implications of this elegant nonhuman research for humans are not fully revealed yet, but it is becoming clear to most scientists that a mother's psychological state in pregnancy has far more impact on her child's subsequent development and health than ever thought before (reviews by Beydoun & Saflas 2008, De Weerth & Buitelaar 2005, Glover & O'Connor 2002, Huizink et al. 2004, Van den Bergh et al. 2005, Weinstock, 2008). O'Donnell et al. (2009), for example, concluded one review by stating, "the evidence for an association between maternal stress, depression or anxiety in pregnancy and an adverse neurodevelopmental outcome for the child is now substantial" (p. 290).

Of note here is evidence that state anxiety and pregnancy anxiety prospectively predict not only earlier delivery, but also a wide range of neurodevelopmental consequences with implications extending into adolescence. Some of the outcomes linked to prenatal anxiety include attention regulation and mental and motor development in the first year of life (Huizink et al. 2002, 2003), infant temperament (i.e., fear; Bergman et al. 2007), negative behavioral reactivity to novelty in infants and 12-month mental development (Davis et al. 2004, Davis & Sandman 2010), behavioral and emotional problems at 4 to 7 years (O'Connor et al. 2002, 2003), decreased gray matter density on MRI scan in 6- to 9-year-olds (Buss et al. 2010), and impulsivity, externalizing, and processing speed in adolescents (Mennes et al. 2006; Van den Bergh & Marcoen 2004; Van den Bergh et al.

2005, 2006). In addition to developmental outcomes, evidence indicates that maternal stress is linked to major mental disorders in offspring (Kashan et al. 2008). Thus, exploring the effects of stress, anxiety, and pregnancy anxiety specifically on developmental outcomes is an active frontier in pregnancy research.

Resilience Resources in Pregnancy

The topic of resilience is a popular one in psychology, yet the term has been used in many different ways potentially leading to scientific imprecision (Carver 1998, Garmezy 1991, O'Leary & Ickovics 1995, Rutter 2006, Tedeschi & Calhoun 1995, Zautra et al. 2010). Broadly, resilience refers to good outcomes in spite of serious threats to adaptation or development (Masten 2001). The term resilience has also been used more narrowly to characterize a subset of adults and children who experience either lower levels or short duration of emotional responses to major traumas such as the 2001 terrorist attacks of the World Trade Center in New York City (Bonanno 2004). Resilient individuals, according to this work, are those who continue functioning or return to functioning rapidly in the face of trauma. Bonanno (2005) argues that there are multiple ways of being resilient.

Although research on resilience in response to trauma has some bearing on understanding resilience in pregnancy, trauma is not as common during pregnancy as is chronic stress. Chronic stress refers to ongoing demands in areas of life such as family, marriage, parenting, work, health, housing, and finances, usually ensuing from either role strains, SES, or both. Low SES poses higher levels of many forms of stress, including higher chronic stress (Baum et al. 1999, Chen et al. 2006) and higher stress hormone levels (Cohen et al. 2006), which may be modified by ethnicity and race. Resilience under chronic stress among low-SES pregnant women is especially important to study given that they have higher rates of adverse birth outcomes, and chronic stress is associated with LBW.

RRs: resilience resources

Resilience in the face of chronic strain is likely to result from one or more personal characteristics or resources that foster the ability to cope well despite extraordinarily severe, repetitive, and long-lasting demands. Early stress researchers drew attention to the importance of various types of resources in the coping process (Lazarus & Folkman 1984, Taylor 1983). For our purposes here, resilience resources (RRs) include (a) ego-related resources such as mastery or self efficacy, perceived control, and self-esteem; (b) social constructs such as social integration, connectedness, and perceived and enacted support; (c) personality factors such as dispositional optimism and conscientiousness; (d) beliefs and values including world views, spirituality, and cultural values; and (e) endowed or constitutional resources such as cognitive ability and absence of disease risks (excellent physical health). Hobfoll et al. (1998) reviewed resource theories of stress and adjustment, highlighting approaches to the study of individual resources (e.g., optimism, self efficacy, or coping) as well as combinations and interactions of multiple resources. Additive combinations of these RRs and their interactions are hypothesized here to influence birth and postpartum outcomes. In addition, some RRs are expected to be moderately correlated, whereas others are likely to be independent.

Pregnant women at risk of adverse birth outcomes due to high chronic stress are likely to fare better in coping if they possess resilience resources, and the more the better. High self-esteem may enable a person to confront authorities when necessary to defend one's rights and obtain good medical treatment or welfare services. Emotional stability may enable a woman to manage a difficult child or an unreliable partner on a day-to-day basis with some equanimity. Being physically strong and in good health in the face of chronic stress to maintain stamina is clearly useful in coping, as is being intelligent and able to problem-solve effectively. Being connected to others and perceiving that support is there if needed is also a well-known coping resource that should figure prominently into adult resilience in the face of chronic strain.

One approach to studying resilience resources in pregnancy has been to combine different resources into a psychosocial index (e.g., Cliver et al. 1992, Nuckolls et al. 1972), although this approach can obscure the independent effects of individual resources. Nonetheless, some of these studies suggest that low levels of mastery, self-esteem, and self-efficacy are associated with LBW and PTB (e.g., Copper et al. 1996, Jesse et al. 2003). In addition, higher self-efficacy and uplifts together predicted lower stress reactivity and better mood in response to a laboratory stressor (Nierop et al. 2008). Methods such as structural equation modeling enable researchers to test combined and independent effects of individual resources on birth outcomes with appropriate controls in the model. Using these methods, a latent personal resources factor (composed of mastery, self-esteem, and optimism) assessed in pregnancy predicted BW controlling for prenatal anxiety and gestational age at birth (Rini et al. 1999), and there were no unique effects of any of the three resources.

Other than social support research (reviewed above), there are only a few existing studies on specific resilience resources in pregnancy. The personal resource that has been of greatest interest is dispositional optimism (Scheier & Carver 1985), defined as generalized expectations that future outcomes will be positive. Greater optimism in pregnant women was associated with higher birth weight after controlling for stress and medical risk in one study (Lobel et al. 2000), although one nonreplication exists (Catov et al. 2009). Optimistic women had lower anxiety and distress in pregnancy, which mediated effects on birth outcomes (Lobel et al. 2000; see also Rini et al. 1999). Optimists are also known to adopt healthier lifestyles. Optimistic pregnant women are more likely to avoid risks such as smoking (Park et al. 1997), to exercise, and to cope more adaptively than pessimists (Lobel et al. 2002). Thus, the pathways whereby dispositional optimism and related concepts such as mastery and self esteem influence pregnancy outcomes may involve health

behaviors and coping, both of which merit further investigation.

Efforts to consider how resilience resources operate in combination have led to the development of general theoretical formulations that may be useful in pregnancy research. Hobfoll (1989) proposed the conservation of resources theory, which posits that individuals try to obtain and conserve resources so as to be prepared to manage stress when it comes along (see also Hobfoll 2001, 2002). More recently, Gallo and Matthews (Gallo et al. 2009, Gallo & Matthews 2003) developed a theoretical formulation to explain the higher rates of cardiovascular disease in low-SES populations. Similar to the conservation of resources theory, they suggest that various types of resources operate as a reserve capacity for addressing coping demands and, importantly, that individuals of low SES have lower resource levels and lower ability to replenish them. This suggests that a person's reserve capacity is like a gasoline tank that may be full or low, which explains why coping effectively is particularly difficult for some individuals compared to others. Although developed for heart disease, the reserve-capacity model has clear applicability to SES-health disparities more broadly and may be useful to apply to ethnic and racial disparities in birth outcomes. What critical resources are specific subgroups of pregnant women most likely to possess or lack? Do they try to conserve and replenish their resources? Can resources be strengthened during pregnancy to influence birth outcomes, or is the building of resources something that must take place preconception? These and related questions are a good focus for the next decade.

Multilevel Models of Birth Outcomes

Despite decades of scientific publications about "psychosocial" influences in pregnancy on birth outcomes, no attempt has been made to model psychological processes in any detail. There is a pressing need for multilevel models of PTB and LBW that include biological, psychological, and sociocultural factors together with

similar detail at each level. Although many models of pregnancy outcomes have appeared in the literature (e.g., Culhane & Elo 2005, Hogue et al. 2001, Misra et al. 2003), they are understandably well developed in the areas of the authors' disciplinary expertise in sociology, public health, obstetrics, or immunology and not typically well developed in other areas. Furthermore, most published conceptual diagrams or models on birth outcomes do not provide details on the psychological processes invoked. The next step for psychological science in pregnancy and childbirth is to develop theory on specific topics such as emotions, behavior, motivation, close relationships, and stress in order to guide biopsychosocial research in the future while at the same time integrating with other levels of analysis. Although examining only one level or set of processes in detail is useful, past research on pregnancy has illustrated that without interdisciplinary study, the ability to understand and improve the outcomes of mothers, their offspring, and their families will be limited.

To this end, Dunkel Schetter & Lobel (2010) provided a rudimentary schematic diagram of multilevel biopsychosocial processes linking stress and birth outcomes, which represents emotional, cognitive, behavioral, and physiological mechanisms linking exposure to chronic and acute stress to PTB and LBW. It also includes contextual factors, such as the physical environment and SES, and their influences on both stress exposure and birth outcomes. However, more detailed conceptions are needed. For example, given convergent evidence of the effects of pregnancy anxiety on PTB, examination of the multilevel theoretical mechanisms involved in this area seems worthwhile.

A Theoretical Formulation of Pregnancy Anxiety and PTB

As noted above, PrA can be defined as fears about the health and well-being of one's baby, of the impending labor and childbirth, of hospital and health-care experiences (including one's

own health and survival), and of parenting or the maternal role. It represents a particular emotional state akin to state anxiety but more contextually based inasmuch as it is specific to women during pregnancy. Moderate levels of PrA are normal, especially for first pregnancies. Different studies have suggested increases, decreases, and stability in the average levels of PrA among women over the course of pregnancy. On the one hand, one might expect the greatest anxiety to be present in the third trimester, as a woman prepares for birth. On the other hand, research has shown that the physiological changes of pregnancy tend to progressively mask emotional and biological responses to stress as pregnancy continues (Glynn et al. 2001, 2004). It is hypothesized here that PrA is likely to be higher in women with fewer resources, but the specific types of resources that most influence PrA are not yet known. Women lacking social support would be predicted to have higher PrA, particularly if they lack information and emotional support to address specific worries about the baby and birth. It is further hypothesized that a combination of high stress and low resilience resources interact to increase PrA. Other hypothesized contributors to PrA are a predisposition to general anxiety, neuroticism or a preexisting anxiety disorder, and medical risk conditions influencing the current pregnancy that are communicated clearly to the expecting mother. Finally, the origin of some PrA may be in early attachment experiences with inconsistent or inattentive caregivers that result in an anxious or insecure adult attachment style (Shaver et al. 1996).

Figure 1 (see color insert) depicts these and other hypothesized predictors of PrA and the hypothesized pathways from PrA to PTB, together with the role of RRs. It shows the influence of PrA on PTB via maternal HPA activity, health behaviors, and immune processes. Although these mediating mechanisms are not diagrammed in full complexity, more finely detailed analyses and models of the immune and HPA processes exist elsewhere in the literature (Coussons-Read 2003, Coussons-Read et al. 2003, Hobel & Culhane 2003, Hodgson

& Lockwood 2010). **Figure 1** also includes hypothesized predictors of PrA, including the influence of life events and other stressors that operate via threat appraisals to heighten PrA. A predisposition to be anxious or a history of an anxiety disorder are hypothesized to influence PrA both directly and via enhanced threat appraisal. Experiences in the health-care system such as poor provider-patient interactions and communication about risks are hypothesized to increase PrA. Cultural beliefs about birth and hospital settings are also hypothesized to influence PrA and a woman's health-care experiences (Campos et al. 2007, Scrimshaw et al. 1997). For example, more-acculturated Latinas have been shown to worry more about the baby's development, whereas less-acculturated Latinas worry more about the hospital delivery experience and whether they will be harmed.

As shown in **Figure 1**, PrA is hypothesized to increase risk of sleep problems and poor nutrition (especially skipping meals and fasting), which in turn influence the immune system adversely and have known neuroendocrine effects (Oken & Coussons-Read 2007). The maternal-fetal-placental triad of interactions is depicted with proximal influence of pCRH on uteroplacental dysfunction and onset of contractions. As noted above, these mechanisms are complex and are not shown in detail but can be found elsewhere to further elaborate the representation in **Figure 1**.

RRs are conceptualized as a collective set of ego-related, social, coping, attitudinal, and inherited or endowed factors with both direct and moderation effects. That is, RRs act directly to decrease PrA and also directly on HPA and immune processes. RRs also modify the effects of environmental inputs (e.g., life events) on PrA and modify the effects of PrA on HPA processes and health behaviors. For instance, episodic and chronic stressors are less likely to increase PrA in the presence of a strong support network or a supportive partner. Furthermore, the effects of stress on physiological reactivity and allostatic load (i.e., wear and tear on the body's systems) are hypothesized to be attenuated when

a person has high mastery, self-esteem, and/or optimism. Whether resources modify specific pathways in combination or individually in pregnancy is not known and can be tested in the future.

Unquestionably, this theoretical analysis is limited in many ways. It is insufficiently detailed at every level, and all possible influences and associations are not shown. For example, emerging work on genetic factors directly contributing to the pathophysiology of PTB is not modeled, nor are gene-environment interactions represented (Wang et al. 2001). Vascular pathways to PTB are not included. Recursive pathways or feedback loops are not shown, for example, the reverse influence of poor health behaviors such as smoking and fasting on increased pregnancy anxiety. Nonetheless, this provides a working framework consistent with the balance of existing data and theory that can guide hypothesis testing regarding many major influences on the etiology of PTB.

Of note, SES is included in **Figure 1** only in terms of higher childhood SES conferring a benefit as a RR. Adult SES would be positively associated with many of the RRs shown. For example, pregnant women of higher adult SES are expected to have stronger mastery and more available social support (Taylor & Seeman 2006). However, past research suggests that women of varying SES and different ethnicities can experience high PrA, which is why SES is not modeled as a contributor. In contrast, low SES is clearly a contributor to chronic stress and is expected to influence the etiology of LBW via various behavioral, biological, and emotional mediators. Therefore, a parallel theoretical model is needed for LBW given the distinct psychological and social processes that appear to be involved. For example, a predictive model of LBW would include unique health behaviors such as smoking that are influenced by chronic stress or depression in the pathways to fetal growth.

Finally, the focus here on anxiety during pregnancy should not permit excessive attributions of responsibility to mothers in cases where infant outcomes are not optimal. While they

have a powerful role in producing healthy infants, mothers are embedded in multiple layers of influence, including social and cultural contexts containing many complex causal determinants that are often uncontrollable. Thus, if blame is to be placed in this framework for maternal and infant health outcomes, let it be placed upon the individual societies that inadequately support the health and well-being of women in pregnancy, and let change begin there. Societies that nourish resilience in mothers and their families are surely likely to see maternal optimality.

CONCLUSION

Psychological science on pregnancy and birth is a unique research context. It concerns women at a critical time in their lives, a time that is infused with significance for their health and well-being and that of their children, partners, and families. At the same time, this research topic is integrally tied to many advances in psychological science. In particular, the study of stress and coping processes, affective science, relationship science, human motivation, and cultural psychology are all highly relevant to deriving more sophisticated and useful theory and research on pregnancy and birth outcomes. A primary goal of this article was to review current knowledge on stress and two important birth outcomes, together with possible mechanisms, and to provide a snapshot of the potential long-term effects. In addition, this review highlights the lack of strong theory and evidence on social processes in pregnancy, particularly emphasizing research opportunities regarding partner relationships and cultural influences on birth outcomes. A second goal was to highlight the key role of pregnancy anxiety in preterm birth and to introduce new theory and a multilevel conceptualization of this emerging concept. Finally, directions for future research are indicated, particularly the need for further development of coping processes and resilience resources in pregnancy, both areas with little published research and interrelated intervention opportunities.

Although the study of pregnancy would appear to be narrow and specialized, the thesis herein is that this research is integral to broader psychological science and that reciprocal knowledge can be built by greater awareness of these issues.

SUMMARY POINTS

1. Stress during pregnancy is implicated as a risk factor for adverse birth outcomes.
2. Pregnancy anxiety, defined as anxiety and fears specifically linked to a particular pregnancy, is emerging as an independent risk factor for spontaneous preterm birth.
3. Chronic stress and depressive symptoms appear to predict fetal growth and risk of low birth weight.
4. The mechanisms for these effects involve multilevel interacting processes including neuroendocrine, immune, and behavioral processes.
5. Prenatal stress and pregnancy anxiety have been shown to have extensive and far-reaching developmental effects on the fetus, newborn, infant, child, and adolescent that are the focus of much current inquiry.
6. Sociocultural processes, including social support, partner relationship, and a woman's cultural milieu, appear to be direct contributors to infant birth weight, although social support has not improved birth outcomes in most past randomized controlled trials.
7. Models of resilience are not developed for pregnancy and birth, and they add to our understanding of the complex processes influencing pregnancy and outcomes for women and infants.
8. A multilevel model of the contributors to pregnancy anxiety and mechanisms or pathways to preterm birth is proposed to guide future research

FUTURE ISSUES

1. To test the antecedents and correlates of high pregnancy anxiety and determine how high pregnancy anxiety influences onset of labor.
2. To investigate the roles that specific resilience factors play in modifying the processes linking pregnancy anxiety to preterm birth.
3. To examine chronic stressors, such as racism and discrimination, including the role of depressive symptoms, as they influence fetal growth and low infant birth weight and to determine the ways in which these pathways are similar to and different from those involved in pregnancy anxiety and preterm birth.
4. To design innovative and evidence-based intervention research to improve birth outcomes and the experience of pregnancy for women as well as to reduce major disparities in these outcomes, and to conduct randomized controlled trials to establish efficacy.

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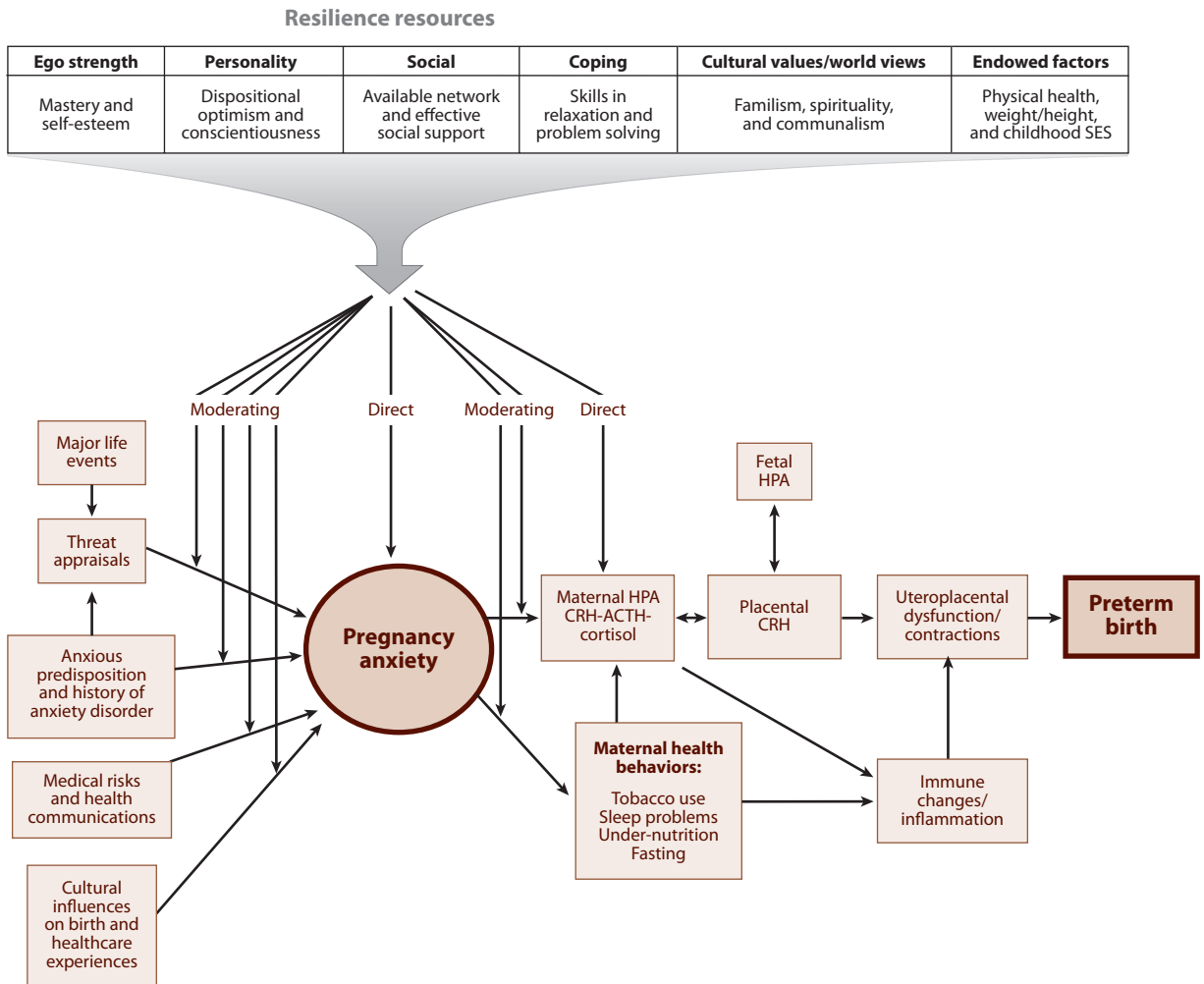


Figure 1
The predictors, mediators, and moderators of the effects of pregnancy anxiety on preterm birth.