Introduction

Research over the past few decades has established that high levels of stress during pregnancy pose risks to maternal and infant health. We now know that the stressful life conditions women may experience during pregnancy and strong negative emotions throughout a pregnancy can affect fetal development, birth outcomes, and increase risk for a variety of poor infant, child, and adult outcomes. Pregnancy is a stressful period for many women because it entails numerous demands and changes in physiology and physical condition, and it portends major changes in roles involving family life. Women may worry about the health of their baby over the course of pregnancy, especially if there are any medical risks involved, and many women are nervous about the impending labor and birth experience. In addition to the pregnancy-related stress that women often experience, pregnant women may be exposed to a variety of stressful home, work, and neighborhood conditions, and some women experience major stressful life events during pregnancy such as the death of a loved one.

The purpose of this article is to summarize existing evidence about the impact of stress during pregnancy. We begin by discussing important maternal and child outcomes. Second, we describe the types of stress that have been shown to be most harmful. Third, we discuss the mechanisms or pathways by which prenatal stress is thought to influence a woman’s birth and her child’s outcomes. Fourth, we provide an overview of some of the factors that can protect against the impact of maternal stress. Fifth, we highlight some new directions in this area of research that may expand our understanding of stress in pregnancy and its effects. Finally, we offer recommendations to pregnant women based on existing evidence and our knowledge and experience as stress and coping researchers.

Outcomes Affected by Prenatal Maternal Stress

Researchers have identified a wide range of health outcomes that are affected by prenatal stress. They fall into three general categories: (1) fetal behavior and development, (2) birth outcomes including the gestational age and weight of an infant at birth, and (3) infant and child health and development. Additionally, there is evidence that exposure to stress prenatally can affect offspring health over the lifespan, a phenomenon known as ‘fetal programming.’ This research indicates that the effects of stress exposures on organ development and growth during gestation increase the risk of later health problems including coronary heart disease, hypertension, Type II diabetes, and some psychiatric conditions (e.g., Barker, 2002, 2007; Betts et al., 2014; Raikkonen et al., 2007; Rich-Edwards et al., 1999).

Of the variety of outcomes that have been studied, two birth outcomes – gestational age at birth and birth weight – have received the most attention by researchers. These outcomes are especially important because ‘preterm birth’ (defined as less than 37 weeks) and ‘low birth weight’ (less than 2500 g, or approximately 5.5 lbs) are often associated with other health and developmental problems and they have substantial medical and behavioral consequences. A full-term pregnancy lasts approximately 40 weeks. Preterm birth and low birth weight often co-occur, because infants born before the full term of pregnancy typically do not have enough time in utero to complete their growth and reach maturity. Preterm birth and low birth weight are both major risk factors for infant mortality, especially in the first month after birth, and they increase the risk of cognitive and neurodevelopmental deficits and mental and physical illness in infancy, childhood, and adulthood among children who survive. For example, infants born preterm or at low birth weight are more likely to be in special education than full term, normal weight children, and the former are less likely to graduate from high school (e.g., Conley and Bennett, 2000; Hack et al., 1995). Preterm birth and low birth weight may therefore be viewed as immediate outcomes that trigger secondary outcomes and contribute to longer-term complications and disorders. Even among infants born at full-term (37–41 weeks), there is evidence of more mature brain development with modest increases in gestation (Davis et al., 2011a), and also evidence that some child and adult problems are more likely for those
with lower birth weight even within the normal birth weight range (Matte et al., 2001; Richards et al., 2001). Because of the abundance of evidence for adverse risks from preterm birth and low birth weight, they are a major public health concern worldwide and a target for prevention. Currently, we know that the etiology of these outcomes, especially of preterm birth, is complex and multi-determined. It is recognized that biobehavioral and psychosocial factors are involved, but there are multiple pathways to preterm birth, only some of which involve stress (Goldenberg et al., 2008; Kramer et al., 2012).

What is Prenatal Maternal Stress?

Numerous types of stress have been examined in pregnancy, but most studies focus on one or more of the following categories of stress: (1) major life events that affect an individual (e.g., death of a loved one, unemployment) or that affect a whole community (e.g., natural disaster). (2) chronic stressful conditions that usually stem from relationships (including interpersonal violence), work, or neighborhood, and (3) stress-related emotions or perceptions of stress, including those related to being pregnant itself, the latter of which is often labeled ‘pregnancy-specific stress.’ In addition, a growing area of research in pregnancy examines stress associated with exposure to racism or discrimination.

Historically, one of the earliest approaches to stress was the measurement of major life events or episodes that a person experienced during a given period of time, and early research on prenatal stress used this approach, typically counting events that occurred during pregnancy or in the time before conception, sometimes also assessing women’s reports of how stressful the events were (see reviews by Dunkel Schetter, 2011; Lobel, 1994). A second longstanding approach has been to study negative emotions that may or may not be stress-related, especially anxiety and depression. Other research on prenatal stress has examined women’s perceptions or appraisals of their pregnancy, and of the conditions that they experience during this time that tax their resources.

Some research teams have developed more extensive approaches to prenatal stress, measuring it as the combination of women’s emotional states and stressful events during pregnancy, and sometimes including women’s perceptions of their circumstances during pregnancy (e.g., Lobel et al., 2008a, 1992; Rini et al., 1999; Zambrana et al., 1999). Studies using these multifactorial approaches have provided strong evidence that stress during pregnancy contributes to earlier birth and lower birth weight. A multifactorial approach may be more powerful than focusing on one aspect of stress (Lazarus and Folkman, 1984; Lobel et al., 2008b), but logistically, it is difficult to collect these data as it requires study participants to complete many measures of stress which can be burdensome. Therefore, an important development in research on prenatal stress has been to establish the conceptual and methodological quality of briefer measures, especially those focused on pregnancy. Although relatively brief, these measures have shown strong predictive validity. That is, women with high pregnancy-specific stress do have a greater likelihood of adverse birth outcomes. We highlight this type of stress measurement below.

Major Life Events in Pregnancy

Rigorous studies suggest that major negative life events and especially those perceived as severe increase the risk of adverse birth outcomes (for reviews, see Dunkel-Schetter and Glynn, 2011; Dunkel-Schetter and Lobel, 2012). For example, death of a relative before or during pregnancy predicted higher risk of preterm birth and low birth weight in a large Danish study (Khaskan et al., 2008; 2009). That said, many studies do not find that life events alone predict adverse outcomes or they find relatively small effects (Lobel et al., 2000; 2008a). In combination with other measures, as in Zambrana et al. (1999), life events counts are sometimes predictors of preterm birth, whereas in other studies, the counts do not predict at all but women’s assessments of the severity of life events combined with perceptions of distress are predictors of outcome (Lobel et al., 1992).

Community Stressors in Pregnancy

More recent work on pregnancy has turned to study of effects of community-level disasters such as terrorist attacks, nuclear disasters, hurricanes, floods, and earthquakes (e.g., Eskenazi et al., 2007; Glynn et al., 2001; Lederman et al., 2004; Xiong et al., 2008). For example, Torche and Kleinhaus (2012) found that women who experienced the Chilean earthquake during the first trimester of their pregnancy had earlier deliveries and lower birth weight infants compared to women not exposed to the earthquake, and this effect was especially strong for female offspring (see also Wainstock et al., 2014 on effects of exposure to intermittent rocket attacks during pregnancy). Developmental effects are also found in studies of disasters such as one of an ice storm (Cao et al., 2014) in which storm-related perceived stress reported by mothers during pregnancy was associated with poorer motor function in female offspring at the age of five. In this study, the later in pregnancy the exposure occurred, the stronger the effects. Again, there are studies of natural and human-made disasters that show no adverse effects on pregnancy and we do not know if that is due to differences in methodology, samples, or simply the variability of effects. Nonetheless, it seems clear that community-level stressors pose risk of adverse outcomes to pregnant women.

Chronic Stressful Conditions in Pregnancy

Chronic stressful conditions represent another category of prenatal stress that has received attention from researchers, and a variety of conditions have been examined. One form of chronic stress ensues from living in neighborhoods or communities that are low income, crowded, and low in resources (e.g., Genereux et al., 2008; Gray et al., 2014; Luo et al., 2006). Such areas can also be high in crime and pollution, and pose other safety issues. One study examined the impact of neighborhood poverty among more than 30,000 women who had given birth in the state of Illinois over a three-year period (Collins et al., 2009). The researchers found that women who resided in a poor neighborhood throughout their lifetime were more likely to deliver a low birth weight infant compared to women who did not live in such a neighborhood. In another
study of low-income women, those who experienced chronic stressful conditions while pregnant such as having a child with a chronic illness, experiencing food insecurity, or living in a crowded home were approximately three times more likely to deliver a low birth weight infant than women who did not experience these chronic conditions (Borders et al., 2007).

Other studies have focused on interpersonal violence during pregnancy, which can be viewed as a specific form of chronic stress. Whether interpersonal violence is more or less likely to be experienced by pregnant compared to nonpregnant women, or whether the severity and frequency of violence against women changes during pregnancy have yet to be determined conclusively (Charles and Perreira, 2007; Jasinski, 2004; Rachana et al., 2002). Nevertheless, interpersonal violence is a potent danger in pregnancy, not only as a chronic stressor, but also because it may involve physical harm to a pregnant woman and her fetus. A meta-analysis of studies (Shah and Shah, 2010) found that women subjected to interpersonal violence during pregnancy were 1.5 times more likely to deliver preterm and also 1.5 times more likely to deliver a lower birth weight infant than women not subjected to violence during pregnancy. Experience of interpersonal violence during pregnancy also increases risk of fetal death and miscarriage (e.g., Ahmed et al., 2006; Ellsberg et al., 2008; Morland et al., 2008). Ongoing research is examining how the impact of interpersonal violence may be exacerbated when it occurs in conjunction with other forms of stress during pregnancy (Cizmeli et al., 2014).

Stressful Emotions and Perceptions of Stress in Pregnancy

State anxiety has often been examined as an indicator of maternal stress during pregnancy (e.g., Ding et al., 2014; Dole et al., 2003; Nasreen et al., 2010). Most studies differentiate state anxiety – a woman’s emotional state at the time of assessment – from trait anxiety, which is a tendency to experience anxiety in general, or a stable individual trait. Evidence is suggestive that anxiety of both types predicts adverse birth outcomes but the findings are not consistent and the effects are stronger when anxiety is combined with other indicators of stress or when the focus is on pregnancy-specific anxiety (Dunkel-Schetter and Glynn, 2011).

Research has also investigated other stress-related emotions, such as depressed mood and depressive disorders (e.g., Hayes et al., 2012; Nylen et al., 2012; Wisner Bogen et al., 2013; Yonkers et al., 2012). A recent systematic review of prenatal depression studies found that in approximately half of published studies, prenatal depression – defined either as depressive symptoms or as clinically diagnosed depressive disorder – is associated with lower birth weight (Accott et al., 2014). This review carefully selected and qualitatively evaluated the studies on this topic and concluded that the evidence is stronger for associations of depression with low birth weight than with preterm birth.

Apart from state anxiety, depression, or other general negative emotional states that women may experience during their pregnancy, emotional distress related to pregnancy itself has also been investigated. This is alternately labeled ‘pregnancy-specific stress,’ ‘pregnancy-specific distress,’ or ‘pregnancy anxiety.’ Studies find that pregnant women may experience this as a result of a number of common concerns or worries (Alderdice et al., 2013, 2012; Dunkel Schetter, 2011; Yali and Lobel, 1999). Pregnant women tend to be concerned about the significance of their physical symptoms and how to manage these symptoms. Many women are also concerned about changes in their appearance, or about changes in their interpersonal relationships. Pregnant women also commonly worry about labor and delivery, about the health of their baby, and about how they will care for the child after birth. Pregnant women who are at particular risk because of medical conditions or prior complicated pregnancies or losses tend to be especially distressed (Woods-Giscombe et al., 2010).

Preterm birth has been shown to occur at least 1.5 times more often among women with high levels of pregnancy-specific stress or pregnancy anxiety (e.g., Dole et al., 2003; Kramer et al., 2009; Orr et al., 2007). For example, a study of 920 Latino and African American adolescent and young women found that levels of pregnancy-specific stress in the third trimester as well as increases from the second to third trimester predicted preterm birth (Cole-Lewis et al., 2014). Recent systematic reviews of research concur that pregnancy-specific stress or anxiety is associated with earlier birth in well-conducted studies (Alderdice et al., 2012; Dunkel-Schetter and Glynn, 2011; Nast et al., 2013; Shapiro et al., 2013).

There are now many measures of pregnancy-specific stress and pregnancy anxiety that differ in various ways including their appropriateness for different populations and their predictive validity (Alderdice et al., 2012; Nast et al., 2013). Some have been developed or translated into languages other than English. The authors of this article have themselves originated measures including the Prenatal Distress Questionnaire by Lobel et al. that assesses pregnancy-specific distress (e.g., Lobel et al., 2008a; Yali and Lobel, 1999), and two measures developed by Dunkel Schetter et al. assessing pregnancy anxiety (Guardino and Dunkel Schetter, 2014; Rini et al., 1999). All of these have strong predictive validity in past studies (see review by Alderdice et al., 2012).

Although pregnancy-specific stress tends to co-occur with general or non-specific stress in pregnancy, a number of studies suggest that of these, pregnancy-specific distress or anxiety is a more powerful predictor of fetal activity, earlier birth, and of developmental outcomes (Davis and Sandman, 2010; DiPietro et al., 2004, 2002; Huizink et al., 2004; Lobel et al., 2008a; Roesch et al., 2004; see review by Dunkel-Schetter and Glynn, 2011). There are several possible explanations for these stronger associations with pregnancy-specific distress or anxiety. First, worries about one’s health and one’s child’s health may be more disturbing and worrisome for pregnant women on average compared to other types of stress. Second, the specific problems that arise related to pregnancy and birth are sometimes new or unfamiliar to women, especially in first pregnancies and among women whose risks and symptoms are different than in a previous pregnancy (Woods-Giscombe et al., 2010). Therefore, women may not have developed successful strategies to cope with this form of stress. Third, pregnancy-specific stress has been shown to involve physiological arousal (DiPietro et al., 2002, 2004; Huizink et al., 2004) which may activate processes that directly impair development, growth, and normal ‘parturition’ (birth). Thus,
pregnancy-specific stress may be a particularly potent type of stress that elevates risk for a variety of poor outcomes.

Racial/Ethnic Discrimination

A rapidly developing area of research focuses on racial/ethnic discrimination in pregnant women of color. A growing number of studies demonstrate that racial/ethnic discrimination is associated with poorer birth outcomes including lower birth weight, clinically defined low birth weight, and preterm birth, even after controlling for other factors that increase the likelihood of these outcomes (e.g., Dominguez et al., 2008; Earnshaw et al., 2013; Mustillo et al., 2004; Rosenberg et al., 2002; see reviews by Dominguez, 2008; Giscombe and Lobel, 2005). Measures of discrimination used in these studies reflect multiple categories of stress that are discussed above, as they may include reports of chronically stressful discriminatory conditions or racially/ethnically related stressful events, both during pregnancy and across the lifetime, as well as perceptions of and emotional responses to such conditions and events (see Nuru-Jeter et al., 2009).

Interest in the impact of racial/ethnic discrimination in pregnancy has been driven by the observation that in the United States, African American women experience disproportionately high rates of low birth weight, preterm birth, and related outcomes (Martin et al., 2013). Evidence indicates that these racial/ethnic disparities are not explained by differences in prenatal care, medical risk factors, health behaviors, biological differences, or socioeconomic characteristics (Giscombe and Lobel, 2005), although some of these factors, such as socioeconomic status, do also contribute to the greater prevalence of adverse birth outcomes in African American women.

Further evidence indicates that American women of color experience greater exposure to stress both before and during pregnancy compared to women of white majority status in the United States and to foreign born women of color living in the United States (Dominguez et al., 2008, 2009; see review by Rosenthal and Lobel, 2011). African American women may also be more psychologically reactive or physiologically vulnerable to stressful conditions in pregnancy (Giscombe and Lobel, 2005), as the results of some studies suggest (Buka et al., 2003; Glynn et al., 2007; Oths et al., 2001). This is hypothesized to occur because of the accumulated impact of stressful conditions across the lifetimes of African Americans that causes greater ‘allostatic load,’ or ‘weathers’ their ability to adapt (Geronimus, 2001; Love et al., 2010; McEwen, 1998).

Recent research suggests that African American women also experience unique sources of stress during pregnancy because of societal attitudes toward them as Black and female as well as pregnant (Rosenthal and Lobel, 2011). Pregnant women of color may also experience discomfort with and distrust of the American medical system, which has historically mistreated people of color (Rosenthal and Lobel, 2011). In addition, African American women have been shown to feel personally responsible for the well-being of their African American communities (Woods-Giscombe et al., 2014) which can elevate their distress (Woods-Giscombe, 2010; Woods-Giscombe and Lobel, 2008).

How Stress Affects Adverse Birth Outcomes

Stressful events such as death of a loved one, community disasters, chronic stressors, and exposure to discrimination do not automatically cause health effects but rather act through physiological and behavioral mechanisms (Cohen et al., 2007) that have received research attention in pregnancy. One set of mechanisms or pathways that explain the impact of prenatal stress on adverse birth outcomes includes the health-related behaviors of pregnant women. Behaviors during pregnancy that are stress related are fasting and poor diet, poor sleep, physical inactivity, and substance use, all of which increase the risk of adverse outcomes such as low birth weight and infant and child health problems (e.g., Holz et al., 2014; Murphy et al., 2013; Neggers et al., 2006; Powers et al., 2013; Savitz and Dunkel-Schetter, 2006). Engaging in a combination of such behaviors may be especially risky, as shown by a recent large study linking these behaviors to greater likelihood of preterm birth (Savitz et al., 2012). Also, many women do not realize that unless medically contraindicated, moderate exercise is beneficial during pregnancy and this misunderstanding helps explain why a large portion of pregnant women are sedentary (Cannella et al., 2010). In contrast, most women are aware of the dangers of substance use in pregnancy and a majority cease or reduce unhealthful behaviors such as smoking and alcohol consumption when they become pregnant (Flynn et al., 2003; Wakschlag et al., 2003). Nevertheless, high stress may derail a woman’s attempts to refrain from harmful practices because stress interferes with self-control (Baumeister et al., 2007) and stress can lead people to respond to situations impulsively by, for example, eating foods that offer immediate pleasure even though they are not healthy.

There is some evidence in nonpregnant individuals that stress is associated with unhealthy practices (Ng and Jeffery, 2003; Wardle et al., 2000; see review by Park and Iacocca, 2014) and this phenomenon has been documented in pregnant women, as well. These studies have found that pregnant women who experience highest stress are the most likely to do things that endanger health, especially cigarette smoking (Auerbach et al., 2014; Lobel et al., 2008a; Rodriguez et al., 2000). Lobel et al. (2008a) found that cigarette smoking was most common among women who experienced high levels of pregnancy-specific stress, and in turn, these women were also the most likely to deliver a low birth weight infant. Similarly, Auerbach et al. (2014) found that women with highest pregnancy-specific stress were the most likely to report health-impairing behaviors that included cigarette smoking and skipping meals. Research on sleep suggests that it may also be an important mediator of stress effects on adverse outcomes (Okun et al., 2009, 2011), in part due to immune dysregulation resulting from chronically poor sleep quality and low quantity.

A second, large category of purported mechanisms linking stress exposures and emotional states to adverse birth outcomes involves physiological processes that are known to be stress responsive. This includes neuroendocrine, immune, cardiovascular, and metabolic mechanisms. Exposure to acute stress is known to cause changes in these systems (Dickerson and Kemeny, 2004; Kudielka et al., 2004; Steptoe et al., 2007) and if extended over time from ongoing aftereffects of acute
events, such changes may increase risk of health disorders. Long-lasting stressors and chronic stress result in wear and tear on the body’s systems which is measurable by biomarkers and collectively referred to as ‘allostatic load.’ Allostatic load markers have been shown to take a toll on health, increasing risk of major diseases and earlier death (Cohen et al., 2007; McEwen, 1998). Thus, a woman who experiences either a major acute stressor in pregnancy such as an earthquake with ongoing negative effects on her life, or who has ongoing chronic stressors such as poverty or a stressful job, is at risk of dysregulated physiological stress responses.

The stress-related biomarkers most often studied in pregnancy are those associated with neuroendocrine changes and specifically the ‘hypothalamic pituitary adrenal (HPA) axis.’ The HPA axis involves the release of ‘corticotropin releasing hormone’ (CRH) from the hypothalamus in the brain in response to acute stress which results in a cascade of further biological effects in the brain and body including release of cortisol into the bloodstream, and if sustained, these HPA effects are believed to portend earlier delivery and adversely influence development of the fetus (Sandman et al., 1997). Evidence confirms that CRH rises exponentially in normal pregnancy with a full-term delivery and that these increases are greater and occur sooner during gestation in women who deliver early (Sandman et al., 1997). However, little human evidence exists as yet to show specific links of stress or distress in pregnancy with cortisol or other HPA markers with few exceptions (Hobel et al., 1999; Kane et al., 2014; Wadhwa et al., 1996). Even fewer human studies show a stress to birth outcome association mediated by stress hormones (cf. Mancuso et al., 2004). There are, however, a growing number of studies showing that stress, anxiety, or depression, and stress hormones such as cortisol in maternal circulation have effects on child outcomes (Buss et al., 2012; Davis et al., 2004, 2007, 2011b; Davis and Sandman, 2010). Animal research also shows that excess circulating maternal stress hormones alter the programming of fetal neurons, together with genetic factors, the postnatal environment, and quality of maternal attention, can influence behavior of the offspring (see review by Weinstock, 2008). In general, this pathway is under active investigation.

Regarding another set of physiological mechanisms, it is well known that infections of the reproductive system such as ‘bacterial vaginosis’ and systemic infections such as human immunodeficiency virus in pregnancy increase the risk of preterm birth and other adversities (National Research Council, 2007; see Romero et al., 2007 for a comprehensive overview on inflammation, infection, and preterm birth). It is also established that stress increases inflammation and can increase risk of some diseases or prolong them (Segerstrom and Miller, 2004). Regarding pregnancy, there is growing evidence linking stress to immune dysfunction and outcomes of pregnancy (see Coussons-Read, 2012 for a review), although this is a newer research frontier. Few studies thus far have connected stress, immune markers, and birth outcomes. One exception is a study which found that associations of general stress and pregnancy-specific distress with gestational age were mediated by levels of circulating inflammatory markers (Coussons-Read et al., 2012). For discussion of the complex immune changes that take place in normal pregnancy and how these may be affected by stress to create inflammatory processes that increase risk of preterm birth as well as other birth and child adversities, see reviews by Christian (2012) and Coussons-Read (2012), among others. In addition, Bronson and Bale (2014) have an animal model which suggests that stress-induced placental inflammation may contribute to higher risk of neurodevelopmental disorders in male offspring particularly.

Regarding cardiovascular processes, preexisting high blood pressure or hypertension in pregnancy is a risk factor for adverse outcomes, and high blood pressure that occurs for the first time in pregnancy (called ‘pregnancy induced hypertension’) is also a major risk factor, and therefore healthcare providers treat it aggressively. In men and women, stress raises blood pressure and contributes to risk of hypertension. Despite these findings, relatively little work has actually measured stress and cardiovascular mechanisms together in pregnancy. Hilmer et al. (2008, 2013) showed in two sets of analyses on a study sample that both general stress and racism reported by African American pregnant women in combination with higher resting blood pressure during pregnancy was predictive of lower birth weight newborns. Future work should examine ambulatory blood pressure readings in pregnancy especially in women prone to adversities of any type.

In sum, there are plausable pathways from maternal stress to behavioral, neuroendocrine, immune, and cardiovascular changes that increase risk of preterm birth and low birth weight and some consistent research findings. Among these are findings on the role of pregnancy-specific stress and its biological consequences (Dunkel Schetter, 2011; Dunkel-Schetter and Glynn, 2011). At the same time, there is much more we don’t know about these mechanisms and their interconnections, such as how the neuroendocrine and immune systems work together in a highly stressful pregnancy. Emerging evidence and theory suggest that there are complex interactions between behavioral and physiological mechanisms and that adverse birth outcomes, especially preterm birth, are probably not due to any single pathway in isolation (Dunkel-Schetter and Lobel, 2012). Instead, there is likely to be a ‘network of pathways’ (Beijers et al., 2014) that together exert effects, and clearly stress is not the only factor in adverse birth outcomes or development.

### Reducing Stress and Its Impact

Current research does not offer clear guidelines for how we can address the issue of prenatal maternal stress to improve outcomes and reduce the distress of women in pregnancy. In fact, many prior attempts to mount large-scale interventions to prevent preterm birth and low birth weight have failed. However, there are clues as to where we can look for ideas and some methods can be borrowed from other areas of research. For example, research on coping informs us about adaptive ways of coping with stress that pregnant women can use, such as approach coping involving problem solving, information seeking, planning, and seeking and optimally utilizing social support (e.g., Borcherding, 2009; Hamilton and Lobel, 2008; see review by Guardino and Dunkel Schetter, 2014). Research suggests that coping has a direct effect on the psychological
states of pregnant women (Giurgescu et al., 2006) and that coping with stress in pregnancy by distancing is a risk factor for preterm birth (Dole et al., 2004; Messer et al., 2005).

A technique for stress reduction in general that is currently quite popular is mindfulness meditation developed by Kabat-Zinn (1994) and based in Buddhist philosophy. An impressive body of research has accumulated on this topic indicating that the learning of cognitive and behavioral practices of being focused on the present moment, meditation, and relaxation can reduce stress and improve physiology and health (Grossman et al., 2004; Hofmann et al., 2010). There is also some evidence that mind-body therapies can be beneficial for pregnant women (Beddoe and Lee, 2008). A few controlled intervention studies with pregnant women have utilized mindfulness meditation with encouraging results and larger controlled studies are in progress. In a pilot study, Guarrdino et al. (2013) found that a modified version of mindfulness training in pregnancy reduced anxiety, perceived stress, and pregnancy-related anxiety, but the effects were not long lasting.

Along different lines, we know that social support can reduce stress and potentially buffer its effects (Uchino, 2009). Women in particular tend to respond to stress by nurturing each other and drawing upon their social relationships (Taylor et al., 2000). These behaviors are accompanied by neuroendocrine responses and together they reduce physiological distress and promote well-being. In a large retrospective study of pregnancy, paternal social support moderated the association of chronic prenatal stress with preterm birth (Gosh et al., 2010). In this study, women with high stress who said they lacked support from the baby’s father during pregnancy were more likely to deliver preterm although this was not true for highly stressed women who reported receiving this support. We also know that social support is associated with better birth outcomes and less postpartum depression whether or not a woman is under high stress (Collins et al., 1993; Feldman et al., 2000). In addition, the quality of the relationship between mother and baby’s father is influential in maternal mental health during pregnancy and postpartum. For example, a study of a diverse sample of mothers found that those with better quality relationships with the baby’s father had more paternal support in pregnancy which predicted less postpartum distress. Interestingly, these mothers later reported that their infants had better temperaments, suggesting an indirect effect of relationship quality and father support on infants’ behavior (Tanner et al., 2012). Similarly, recent research showed that women with family support during pregnancy had lower risk of postpartum depression and that stress hormones mediated this association (Hahn-Holbrook et al., 2013). Furthermore, familism, a culturally embedded set of values and tendencies to rely on family among women of Latin American origin or descent, is associated with more support and higher birth weight in this group (Campos et al., 2008).

Despite evidence in general and in pregnancy that social support is potentially beneficial to maternal and child health, supportive prenatal interventions designed to improve birth outcomes have not been very promising thus far (Lu et al., 2003) with a few exceptions (e.g., Norbeck et al., 1996). Possible reasons include a variety of complex issues, including from whom support of each type should come, the quality of support, as well as negative social processes that can accompany support such as obligation, resentment, or conflict (Brooks and Dunkel Schetter, 2011). Pregnancy researchers have discussed and investigated some of these issues (Pietromonaco et al., 2013; Rini and Dunkel Schetter, 2010; Rini et al., 2006), but there is much more to learn before we can make strong recommendations about how to enhance support to improve the welfare of specific cultural, ethnic, and socioeconomic subgroups of pregnant women. What we do know is that the baby’s father occupies a critical role in his potential to support a healthy pregnancy (Lu et al., 2010), and that female family members such as a pregnant woman’s mother (Norbeck et al., 1996) and friends, particularly women who have been pregnant or other pregnant women with whom a woman interacts (Dias and Lobel, 1997; Ickovics et al., 2007), may be quite beneficial. Supportive interventions can be delivered on an individual or a group basis.

Concerning group-based social support, ‘Centering Pregnancy’ is a multipronged group-based prenatal care program that includes as one component information and peer support and it has been shown to reduce preterm birth and have other physical health and psychosocial benefits (Ickovics et al., 2007; Picklesimer et al., 2012). Not all studies have found it to be an improvement over standard prenatal care (e.g., Shakespeare et al., 2010), but this may be because the benefits of the program are closely related to how well it is implemented by group facilitators (Novick et al., 2013), and there is some evidence that its psychosocial benefits occur only in highly stressed participants (Ickovics et al., 2011). Nonetheless, this program has much promise.

Beyond these avenues for intervention in maternal and child health, women who tend to be optimistic and high in mastery and self-esteem have healthier pregnancies and better outcomes. These resources were associated with lower stress and, indirectly, with higher birth weight in one study (Rini et al., 1999), and dispositional optimism specifically was associated with lower emotional distress, more adaptive ways of coping, and greater birth weight in other research (Lobel et al., 2000, 2002).

Another resource that is promising is religiosity or spirituality. In a recent prospective study, African American mothers who were more religious and more spiritual had fewer depressive symptoms during the year following birth (Cheddle et al., 2014). African American fathers in the same study were less likely to have depressive symptoms following the birth of a child when they were lower in avoidant coping tendencies (Bamishigbin et al., 2014). There is still much to learn about risk and resilience factors in maternal mental health, birth outcomes, and fetal and early child development, but newer approaches are gaining some ground in understanding resilience and how to enhance it (Dunkel Schetter and Dolbier, 2011). Newer approaches to improving outcomes not only intervene in pregnancy when risks become apparent, but focus on the preconception period and on mounting interventions before and between pregnancies to have a better chance of influencing complex prenatal physiology and maternal and child outcomes that trace back long before pregnancy (Chang et al., 2013; Flood and Malone, 2012).

Although there are international efforts in place now to screen for depression in pregnancy, thus far there are no efforts
to routinely screen for stress or pregnancy-specific stress or anxiety, perhaps because there are no agreed-upon screening instruments or methods to reduce stress. Yet, there is increasing recognition among healthcare providers of the value of stress screening and intervention in their pregnant patients (e.g., Cardwell, 2013).

Future Directions in Prenatal Stress Research

A topic of considerable interest to researchers is whether there are critical time periods during pregnancy when women may be particularly sensitive or vulnerable to stress. Results of studies to date are not consistent. Some have found that the first trimester of pregnancy (i.e., first 13 weeks approximately) is associated with greatest risk of adverse outcomes (Dancause et al., 2011; Glynn et al., 2004; Lederman et al., 2010; Torche and Kleinhaus, 2012; Zhu et al., 2010), whereas other studies have found that outcomes are worst when stress arises in mid- (Class et al., 2011) or late (Cao et al., 2014) pregnancy. Most likely, at different times in pregnancy the stress has different effects on fetal development and birth outcomes and with time we will clarify this matter. For example, Dancause et al. (2011) reported that gestational age and birth weight were affected among women who were in early or mid-pregnancy when a serious ice storm occurred, whereas Cao et al. (2014) found poorer motor function in the female (but not male) offspring of women who were in their third trimester of pregnancy during the same storm. In addition, some research suggests that patterns of stress across pregnancy may be more predictive of poor outcomes than absolute levels of stress at any particular time (Glynn et al., 2008). This makes sense in that stress does not usually start and end with the timing of trimesters but tends to be an ongoing experience or condition for most women. In sum, issues of the timing of prenatal stress appear quite complex and require further investigation. Recent research adds the influence of preconception stress as a risk factor worthy of attention (e.g., Class et al., 2013).

Another issue for future studies involves the importance of interdisciplinary approaches that can better address the complexity of processes involved in psychosocial and other risks in pregnancy and birth. As we have discussed in this article, stress involves emotions, perceptions, and other reactions that can affect health behavior and potentiate physiological processes that influence normal pregnancy, fetal development, growth, and childbirth, and as we described in an earlier article, this all takes place in the broader context of a woman’s social relationships and communities and the larger social structure (Dunkel-Schetter and Lobel, 2012). Prenatal stress effects illustrate that health is influenced by interactions among biological, psychological, and social phenomena, which scientists label the ‘biopsychosocial model’ of health. Understanding the complex biopsychosocial mechanisms implicated in prenatal stress effects draws on knowledge from multiple fields, and therefore it is likely that future advances in this area of study will be propelled by interdisciplinary approaches involving expertise from a variety of fields such as obstetrics, psychology and other social sciences, nursing, biological science, public health, and other relevant disciplines.

Recommendations for Pregnant Women

Based on existing evidence about how prenatal stress can adversely affect women and children, and our knowledge and experience as stress and coping researchers, we tentatively offer some recommendations to women who are experiencing high levels of stress during pregnancy. First and foremost, bring it to the attention of your physician or other healthcare providers who should be made aware of this and may have some useful suggestions. If you are experiencing distress because of worries about physical symptoms or bodily changes, or if you are nervous about the impending birth, a healthcare provider may be able to provide information about pregnancy and birth that alleviates some of your concerns. Studies indicate that having information about what may happen during pregnancy and during labor and delivery may reduce your stress and can even reduce the likelihood of some birth complications (Lobel and DeLuca, 2007). Other research suggests that being informed about what may occur during childbirth can also improve your adjustment and mood following birth, especially if you have an unexpected ‘cesarean section,’ or surgical delivery (DeLuca and Lobel, 2014). However, we do not believe that you should rely on your providers alone for information and advice since their office hours are relatively short and they have many things to attend to in providing prenatal care for each woman. So supplement your providers’ advice with authoritative books such as Dr. Riley’s (2012) book entitled You and Your Baby Pregnancy, Dr. Lu’s (2014) book entitled Get Ready to Get Pregnant which is written for preconception preparation, the book What to Expect When You’re Expecting (Murkoff and Mazel, 2008), or reputable Internet sites such as those of the March of Dimes, National Institute of Child Health and Human Development, and Planned Parenthood Federation of America Inc.

In addition, as a step in reducing stress, it is often helpful to identify the conditions that are causing feelings of anxiety and distress and consider whether you can change or eliminate any of them. Sometimes this requires taking time to reflect or keeping a diary or list, or talking with a trusted confidante or counselor. It may be valuable to request help from others in coping with the stressors that you identify. For example, family members, friends, clergy, or hospital social workers may be able to provide assistance or direct you and your family to good sources of extra assistance. Help with childcare, household tasks, and financial assistance may be what is needed and seeking them out is a strong act of coping. In addition, looking for local resources that offer stress reduction, prenatal exercise or yoga, support groups, or meditation may be appropriate for those who are interested. Finally, it is especially important to remain conscientious about your health, including eating a healthy diet, getting enough rest and exercise (unless a healthcare provider has advised against exercise), refraining from harmful behaviors such as cigarette smoking and alcohol use, and receiving regular prenatal care. Some types of stress may be unavoidable or unmodifiable, so it is particularly important to take care of your health to minimize controllable health risks that are well known to affect a baby. The good news is that low levels of stress and short-lived, acute episodes of stress that do not have lasting repercussions do not seem to have adverse effects and in some research they may even have benefits for offspring (Sandman et al., 2012) by conditioning the neural system for life.
Conclusions

There is now a wide variety of evidence examining various types of stress in many samples of pregnant women, which demonstrates unequivocally that prolonged or high stress poses increased risks in pregnancy of adverse birth outcomes, fetal growth and development, and of effects on infant, child, and even adult physical and mental health outcomes. Our work establishes that certain forms of stress related to pregnancy (distress and anxiety) are most potent. In addition, we are increasingly learning about the behavioral and physiological mechanisms that may be responsible for these effects. Although this article focuses on the specific risks of stress for pregnant women and their children, it is important to remember that humans are resilient (Dunkel Schetter and Dolbier, 2011). Stress is ubiquitous in life, but it is also clear that stress does not prevent the birth of mostly healthy children. Why not? One reason is that humans have evolved to adapt to stressful conditions, to survive, and to reproduce (Nesse et al., 2007). In addition, pregnant women have specific biological mechanisms to protect the fetus from exposures of many kinds (e.g., Ghaemmaghami et al., 2014; Sandman et al., 2012).

There is also growing research on the particular problem- and emotion-focused ways of coping that are used successfully by pregnant women to manage stress (Guardino and Dunkel Schetter, 2014; Hamilton and Lobel, 2008). Nevertheless, the risks caused by stress to individual pregnant women and their children can create far-reaching consequences and individual and societal burdens, particularly for socioeconomically disadvantaged families and the healthcare systems that serve them. Alarmingly, the United States has one of the highest rates of adverse birth outcomes among industrialized countries and concerns are growing over the increasing prevalence of low birth weight and preterm birth in other countries as well (Blencowe et al., 2012; Chang et al., 2013). It is therefore incumbent upon us to continue research to document and understand the effects of stress and related risk factors in pregnancy, to use our resources to reduce or eliminate these risk factors, and when that is not possible, to reduce or eliminate their impact.


References


