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Elizabeth Burns Date

Prevalence and Trends of Stressful Life Events among Pregnant Women 2000-2010

By

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MPH

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Prevalence and Trends of Stressful Life Events among Pregnant Women 2000-2010

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An abstract of
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Abstract

Prevalence and Trends of Stressful Life Events among Pregnant Women 2000-2010

By Elizabeth Burns

Stress is associated with poor health outcomes and may partially explain differential adverse birth outcomes among women with no known risk factors. Previous research has suggested an association between prenatal stress and adverse birth outcomes, such as preterm birth (<37 weeks gestational age) and low birth weight, (<2500 grams), as well as peripartum anxiety and depressive symptoms. Prevalence and trends in prenatal stressful life events are useful information for clinicians in order to understand the risk profile of their patients. We examined trends using data from the Pregnancy Risk Assessment Monitoring System (PRAMS) from 2000-2010 to calculate the prevalence and trends of thirteen stressful life events (SLE), 4 stress constructs (financial, emotional, traumatic, and partner-related), the presence of one or more SLEs, and mean number of SLEs using self-reported data from 180,902 women in 10 states. We also calculated 2010 prevalence estimates for the 4 SLE constructs, the presence of 1 or more SLEs, and mean number of SLEs by maternal demographic characteristics and state of residence, for 36,891 women in 26 states. Trend analyses were adjusted for maternal race/ethnicity, maternal age, maternal education, marital status, and Medicaid use for prenatal care. We found that the prevalence of any SLE, all four constructs, and mean number of SLEs experienced in the 12 months prior to a live birth decreased slightly between 2000 and 2010. The downward trend remained statistically significant after adjusting for women's demographic characteristics. The majority of individual SLE also decreased (12 of 13) after adjusting for maternal demographics. However, even with decreases over time, over 70% of women delivering a live birth in 2010 reported experiencing one or more SLEs, with financial SLEs the most commonly reported. In 2010, report of SLEs varied by state and demographic characteristics, with women in Oklahoma and West Virginia, younger women, less educated women, unmarried women, and women covered by Medicaid reporting the highest number of SLEs. SLEs are common among pregnant women across demographics. Given the association of SLEs with adverse pregnancy outcomes in other studies mediating their affect during pregnancy should be a target among clinicians and public health professionals.

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Chapter 1

Stress and its Relationship with Adverse Pregnancy Outcomes

In the United States in 2011, 24% of adults self-reported high levels of stress according to a 10-item perceived stress scale [1]. A recent cross-sectional study among 1,522 pregnant women at a single university obstetric clinic found that 78% reported low or moderate stress levels and 6% reported high stress levels [2]. Stress is associated with poor health outcomes in general, and may be associated with adverse birth outcomes such as preterm birth (<37 weeks gestational age), low birth weight (<2500 grams), and small for gestational age (< 10th percentile in size for gestational age) [3, 4].

Preterm birth is the leading cause of neonatal death in the United States and is a significant contributor to neurological impairment in children [5] . Preterm birth is associated with a high cost of health care; recent estimates place the current total annual cost of preterm birth at $26.2 billion or $51,000 per preterm infant [6]. The prevalence of preterm births in the United State rose 30% from 1981 to 2006 to a peak of 12.8% of births but recent data has suggested the trend is reversing [7]. Currently 12% of births in the United States are classified as preterm [8]. Approximately 50% of women who deliver preterm have no identified risk factors [4].

Despite decades of research, the association between stress and pregnancy outcomes remains unclear. The high prevalence of prenatal stress coupled with plausible physiological pathways leading to adverse pregnancy outcomes, such as preterm birth and low birth weight, have spurred research in the area [9]. Some epidemiologic studies have shown strong evidence that stress leads to poor

pregnancy outcomes, while others have not [10, 11]. Current research has focused on defining more clearly what "stress" is and taking into account that certain factors such as social support and coping behaviors may mediate the body's response to stress [12].

Physiological Pathways between Stress and Adverse Pregnancy Outcomes

Three main physiologic mechanisms have been proposed to explain the relationships between stress and adverse birth outcomes: neuroendocrine, inflammatory/immune, and behavioral [9].

Neuroendocrine Response

Within the neuroendocrine system, the hypothalamic-pituitary adrenal (HPA) axis moderates the non-pregnant individual's response to stress (Figure 1). Corticotrophin-releasing hormone (CRH) mediates the brain's response to stress and initiates a cascade in which the pituitary gland releases adrenocorticotrophin hormone (ACTH). ACTH is transported from the pituitary gland to the adrenal gland where the production and secretion of cortisol is stimulated. Cortisol inhibits the body's acute response to stress and suppresses further production of ACTH and CRH. Prolonged stress can lead to dysregulation of the HPA axis and is associated with disease.

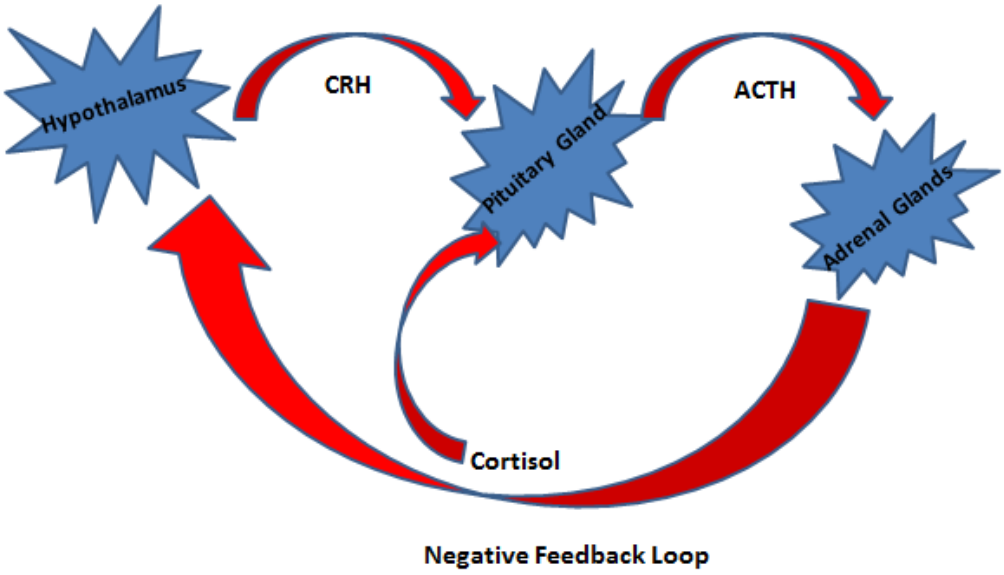

Figure 1. Normal function of the hypothalamic-pituitary-adrenal axis (HPA).

In cells of the placenta, the negative feedback loop does not occur leading cortisol and other glucocorticoids to increase CRH production. Although there is a 20-fold increase in CRH levels over pregnancy as a whole, the increased concentration of CRH binding protein typically limits increased biological activity during the first and second trimester [9]. Placental CRH levels are postulated to increase during pregnancy, in part, to control the initiation of labor by causing the contraction of the myometrium and initiating an autocrine and paracrine response to ready the uterus and fetus for birth. It accomplishes this by signaling the fetal pituitary-adrenal axis to make ACTH, cortisol and estrogen precursors. The positive feedback loop may help mediate maternal and fetal response to labor. Elevated levels of placental CRH are found in women at 38-40 weeks who deliver a term baby but not in women who deliver post term [13]. However, a hyperactive HPA axis before term could explain the association between CRH levels and preterm birth [9].

Up to 25% of preterm births are accredited to stress's influence on the neuroendocrine system [12, 14]. In studies measuring CRH and CRH-binding protein in pregnant women, those who delivered their infants preterm had higher levels of CRH and decreased levels of CRH-binding proteins early in their pregnancies compared with women who delivered full term infants [15-18]. Mancuso found that women who would go on to deliver preterm had 3.3 and 1.3 times higher levels of plasma CRH measured between 18-20 weeks and 28-30 weeks respectively compared to women who had term infants [15]. Others have found similar results although the timing of measurement varied [16, 18]. A strong positive correlation has also been shown between placental CRH measured at 31 weeks gestation and infant physical/neuromuscular maturation after adjusting for gestational age [19]. Researchers reported that each unit increase of placental CRH (pg/mL) was associated with a 0.006 decrease in physical/neuromuscular maturation.

Inflammatory Response

The body's inflammatory response is also associated with preterm birth. Stress on the body increases proinflammatory cytokines, leading to increased prostaglandin production. The presence of prostaglandin in pregnant women leads to uterine contractions and labor and may cause preterm birth [8]. Numerous studies in the general population have noted increased cytokines in individuals experiencing stress [8, 20, 21], but infection also increases their production. The cytokines most likely to affect gestational age are Interleukin-1 (IL-1), Interleukin-6 (IL-6) and Tumor Necrosis Factor (TNF-α), which are found in miniscule amounts during pregnancy in the amniotic fluid and vaginal tract

[20]. IL-6 levels are elevated in the amniotic fluid of women who both give birth preterm and have bacteria in their vaginal tract [22]. The presence of IL-6 and TNF-α in the lower vaginal tract has also been shown to be associated with preterm birth [23]. While elevated proinflammatory cytokines can be explained by the presence of bacteria, women with no sign of infection who experience preterm labor also have elevated maternal serum levels of IL-6 [24]. This finding has lead researchers to suggest that other exposures, such as stress, contribute to preterm delivery through elevation of proinflammatory cytokines, though no definitive studies linking stress inflammation and preterm birth exist. A relationship between chronic stress and vaginal bacterial infection, a risk factor for preterm birth, has been documented, which suggests the possibility of a relationship between stress, inflammation, and preterm birth [20].

Behavior

Stress may also influence an individual's behavior, such as smoking and drug use, as well as sleeping and eating habits. The literature indicates a strong relationship between smoking and both preterm birth and low birth weight [12, 25]. Poverty-related stress may correspond with increases in unhealthy behaviors and may explain, in part, why low income women have a higher risk of preterm birth [26]. While research has not determined a clear pathway of stress affecting behavior resulting in pregnancy complications, there is strong evidence that stress is associated with poorer health behaviors during pregnancy and that some of those behaviors are linked to adverse outcomes, such as preterm birth [14].

Animal Models

Many animal studies regarding health and stress have been conducted, but most are not relevant to a human model because placental CRH is excreted only in humans and the neuroendocrine pathway is assumed to be the primary mechanism for the effects of stress on obstetric outcomes. Additionally, the magnitude of the effect of preterm birth on health is not present in non-mammalian species where physical and neurological development occur at younger gestational ages compared to humans. A few studies in Rhesus monkeys have linked acute stress to increased cortisol levels as well as poor immunity and delayed growth [27].

Overall, conflicting evidence exists concerning the strength of association between stress and adverse birth outcomes, yet a growing body of research demonstrates that stress is an important predictor of poor birth outcomes.

Assessing Stress

The presence of stress during pregnancy has been measured a number of ways to assess its prevalence and examine its relationship with adverse pregnancy outcomes. In a systematic review of 138 studies, 85 different validated instruments were used to examine the relationship between stress and adverse pregnancy outcomes [28]. Chen organized the instruments into 5 domains: life inventory of events; perceived stress scales which measured things such as work strain and racial discrimination; measured enhancers of stress which focused on depression and/or anxiety; buffers of stress such as coping and social support scales; and an "other" category which included pregnancy-specific stressors as well as scales that measured physical well-being, family cohesion, acculturation,

and resources. There is no consensus among researchers as to what "stress" is, which may hamper conclusive results [14].

Biological assessment

As stated above, most epidemiologists measure stress in study participants by self-report using screening instruments. However, several studies have measured biological markers of stress, including CRH in maternal plasma, as well as, cortisol levels in hair, saliva, and serum. Research supports the association between maternal CRH levels and preterm birth [9, 20], but the evidence for a correlation between maternal CRH and self-reported stress remains mixed [29]. Hobel et al. found a correlation between psychosocial stress level and elevated maternal CRH, but the association varied by whether the woman gave birth prematurely [18]. Other research groups in North Carolina and Montreal have failed to measure a significant association between CRH and self- reported stress [29, 30]

Cortisol is used frequently as a biomarker for stress in studies with a molecular epidemiology component, but its utility may be overstated. Studies in both pregnant and non-pregnant individuals have reported mixed conclusions for the significant of association between stress and cortisol levels. A 2004 systematic review of 73 studies found no association between self-reported stress and salivary cortisol levels in non-pregnant individuals. Researchers noted that the lack of association could be due to the multitude of stress assessment surveys used as well as differences in the salivary cortisol collection protocols [31]. Several studies have attempted to establish a relationship between self-reported stress and cortisol levels in pregnancy [29]. Among 112 women with singleton

pregnancies, Voegtline et al. found no correlation between hair and salivary cortisol levels and self-reported stress measured using multiple validated instruments at 5 time points during the pregnancy, but they did find minor associations between anxiety and depression at 30-32 weeks gestational age and cortisol levels [32]. A similar study by Harville et al. analyzed saliva samples from 1,587 pregnant women who had provided samples between either 14-19 or 24-29 weeks gestation and found no association between salivary cortisol levels and self-reported stress and anxiety [30]. Stress was assessed concurrently with saliva sampling.

Self-reported assessment

In epidemiological studies, stress is often assessed retrospectively using questionnaires measuring differing inventories of stress including: stressful life events, daily hassles, perceived stress and pregnancy-related stress or anxiety. The types of stressful life events assessed vary across studies [27] but generally include events such as divorce, job loss, major illness or death of a family member or friend [33]. While study instruments mostly focus on acute stressors present during pregnancy, most studies do not assess when during pregnancy the stressful events occurred [28]. Some studies have also examined stressful events that occur before conception [10]. The stressful life events may be examined independently of one another or as a cumulative measure. Using population-based data from the Pregnancy Risk Assessment Monitoring System (PRAMS), Whitehead et al. developed a threshold model to examine the relationship of stressful life events and preterm birth. Whitehead theorized that a woman could experience a certain number of stressful events without effect, but once she

reached a threshold, each additional event would result in a higher risk of preterm birth [34]. The models, stratified by parity, fit better than a simple linear model for some years, but results were inconsistent overall. Other researchers, using the inventory of stressful live events, have relied on principle component analysis to group events into four constructs (financial, emotional, traumatic, partner) [35]. Researchers have noted that certain stressful life events may not be equally stressful to all individuals, which is a weakness of an inventory-based approach [11].

Other studies have examined chronic stress and its relationship with pregnancy outcomes. Chronic stress is usually defined as the continuous demands in life that may be related to socioeconomic status [12], including racism. Chronic stress is seen to contribute to a greater allostatic load, or constant wear and tear on the body. This type of "weathering" may explain the persistent differences in birth outcomes between African American and non-Hispanic white women [36]. African American women have a 60% excess risk for moderate preterm birth and are 2.5 times as likely to have a very early preterm birth compared with white women [37]. African American women with some tertiary education also have a higher risk of infant mortality (11.1 death/1000 live births) compared to non-Hispanic white women who have not attended college (6.6 deaths/1000 live births) [38].

Other researchers consider stress within a life course perspective. Researchers assert that an assessment of stressful life events during pregnancy provides only a limited view of the amount of stress a woman has experienced over the course of her life. Instead, the life course perspective relies on the

allostatic load and "weathering" hypothesis as well as epigenetic changes that may occur to women when they themselves are in utero [37]. Evidence to support fetal programming includes a study of women who were born during the Dutch Famine of 1944-1945 [39]. Women exposed to the famine prenatally went on to deliver infants of low birth weight more often than their non-famine exposed siblings.

Finally, some studies also take into account stress mediators such as social support, personality, and perception of stress in their studies. Hogue et al. theorizes that the lack of conclusive evidence favoring stress as a cause of preterm birth or low birth weight is due to methodical inconsistences, not the absence of an association [40]. They theorize an epidemiological framework for assessing stress with an agent, host, and environment model. The host is the pregnant woman, the environment is the factors that modify and influence stress (e.g., social support, financial assistance, personality), and the agent is the acute stressful event. Hogue's model suggests that experiencing a single acute stressful life event or even several chronic stressors are not enough to overwhelm the host, but exploring the environment further may lead to the identification of conditions that may cause a woman to experience preterm birth [40].

Social support is generally assessed using self-reported information on connections with the partner or father of the baby, family, friends as well as an extended network. Feldman et al. reported that the presence or absence of social support determined 31% ($p < .01$) of the variance in low birth weight adjusted for gestational age. However, they found no relationship between the presence of social support and length of gestational age [41]. Feldman et al. posit that social

support affects obstetric outcomes both directly through care of the mothers and indirectly by reducing maternal stress and supporting adoption of healthier habits including regular prenatal care [41].

Personality traits such as optimism may mediate the relationship between stress and poor birth outcomes. For example, one study showed a positive association between high optimism and higher birth weight [42]. Resilience, defined to include high self-esteem, perceived connectedness to community, optimism, cognitive ability and belief systems, may also mediate the association between stress and adverse birth outcomes [4, 43].

Reviews on Stress and Adverse Pregnancy Outcomes

Austin et al. conducted a systematic review of large prospective studies published between 1980-2000 examining the relationship between stress and adverse pregnancy and infant outcomes as well as neuroendocrine responses. The authors found eighteen studies meeting their inclusion criteria and examining antenatal stress and obstetric outcomes and three studies that looked at the relationship between reported stress and neuroendocrine response. Overall, the authors concluded that the presence of antenatal stress was associated with increased preterm birth. Within their review, the authors included several Dutch and Scandinavian studies with large population-based samples [11]. In one of those studies of 5,873 women, Hedegaard et al. found no association between a life event inventory and preterm delivery (adjusted risk ratio [aRR] 0.95, 95% Confidence Interval [CI] 0.66, 1.35), but reported that having a large number of events perceived as stressful increased the risk of preterm delivery compared

with women who did not perceive the life events as highly stressful (aRR 1.76, 95% CI 1.15, 2.71))[44]. Nordentoft et al. also reported an association between perceived stress and preterm birth, specifically among women with 10 or fewer years of education. Among women reporting stress, those with 7-9 years of education had an adjusted odds of having a preterm birth 2.62 times higher than women with 11+ years of education (95% CI 1.61, 4.30) [45]. Jacobsen et al. found no statistically significant relationship between stressful life events and low birth weight [46]. Brooke et al. found an association between stressful life events and birth weight that disappeared after controlling for smoking (aOR 1.03, p=0.75) [47]. A similar prospective study published in 1993 found comparable results [48], but Austin notes that neither study assessed perceived stress [11]. Dunkel-Schetter's research group at the University of California Los Angeles reported that women who experienced high levels of stress, defined as a composite of the Stressful Life Event inventory and perceived stress scale and an anxiety assessment, had 4.12 times greater risk for preterm birth than woman who did not experience high levels of stress ($p<0.001$) [49]. Dunkel-Schetter and colleagues found that pregnancy-specific fears about pregnancy and labor were stronger predictors for preterm birth than demographic characteristics, such as age, parity, socioeconomic status (SES), and marital status. The research group eventually defined these stressors as a new construct that they called "pregnancy-related anxiety", which has been used by other researchers. Cooper et al. focused on stress in low SES populations and examined the relationship between low birth weight and preterm birth and self-reported stress, depression, anxiety and self-esteem. The authors reported that perceived stress was the only variable

associated with a significant increase in in the odds of preterm birth (OR 1.16, 95% CI 1.05,1.29) [50]. Honnor et al. also examined a low SES population and found no significant association between preterm birth and stressful life events [51]. Lou et al. matched a group of 70 pregnant women with high stress levels with 50 pregnant women with low stress levels and found a 0.06 week decrease in gestational age at birth for every self-reported stressful event (p=0.04) [52].

Subsequent to the systematic review published by Austin et al., Witt et al. conducted a systematic review of population-based studies published from 2000 to 2012 examining the association between stress before or during pregnancy and pregnancy-related outcomes (pregnancy complications, non-live birth, preterm birth, very low birth weight, low birth weight, or small for gestational age). They found 13 studies that met their criteria, including 6 US studies, of which 3 used data from PRAMS. Witt et al. delineated stress studies into multiple domains based on how the authors measured stress: biological measures of stress (of which there were none); psychological stress, defined as the participants' self-rated perception of stress; environmental stress, defined as the presence or absence of life events considered stressful; and a combination of environmental and psychological stress. Three of the U.S. studies used PRAMS data and, thus, measured stress using the Modified Life Inventory included in the survey. Other studies used non-validated, short questionnaires [53, 54] or the presence of singular events (death of first degree relative, presence in NYC during 9/11) to establish whether the woman had experienced environmental stress before or during pregnancy. Two studies examining psychological stress used the *Perceived Stress Scale* either continuously [55] or categorized into "no

stress", "low stress", "moderate stress", and "high stress" constructs [54]. The other two studies that assessed psychological stress used their own survey [53, 56]. The majority of the studies examined environmental stressors only (69.2%), while others examined psychological only (15.4%) and both environmental and psychological (15.4%) [10].

Witt's review found that the association between stress and adverse birth outcomes was strongest when stress was experienced prior to conception, which is consistent with a life course theory of stress presented by Kramer [37]. All three Danish studies found that the death and/or serious illness of a relative *before* pregnancy (6-11 months prior to conception) increased the risk of either preterm birth or delivering a small for gestational age infant [57-59]. The Danish studies also found that environmental stressors were invariably associated with an increased risk for being small for gestational age and having a low birth weight infant. The association between environmental stressors and preterm birth was less consistent, as was the relationship between psychological stress and adverse pregnancy events. The three U.S. studies that used PRAMS data had differing conclusions. Two of the studies used constructs to classify stressors [60, 61]. Nkansah-Amankra analyzed South Carolina data from 2000-2003 and found a relationship between emotional (aOR 1.41, 95% CI: 1.35, 1.47) and traumatic (aOR 1.07, 95% CI: 1.03, 1.12) stressful life events and preterm birth but not between financial (aOR 0.96, 95% CI: 0.92, 1.00) or partner-related stressful life events (aOR 0.89, 95% CI: 0.86, 0.94) and preterm birth [60]. Nkansah also found an association between all constructs and low birth weight (emotional aOR 1.31, 95% CI: 1.25, 1.38; financial: aOR 1.16, 95% CI: 1.10, 1.22; partner aOR: 1.16

95% CI: 1.11, 1.22; traumatic aOR 1.14, 95% CI: 1.09, 1.20). Researchers adjusted for maternal income level, age, marital status, education and race. Lu et al., in contrast, analyzed data from 19 states in 2000 and found no statistically significant associations between the four stress constructs and preterm birth after adjusting for maternal age, education and marital status (emotional aOR 1.05, 95% CI 0.94, 1.18; financial aOR 1.05 95% CI: 0.94, 1.19; partner aOR 1.04, 95% CI 0.92, 1.18; traumatic aOR 1.00, 95% CI 0.87, 1.16) [60]. The previously mentioned Whitehead et al. threshold model found that for primiparas women, there was a linear relationship between number of stressful life events reported beyond two, and increased odds of preterm birth in 1994-1995 (aOR 1.05, 95% CI 1.02, 1.08), but not in 1990-1993 (aOR 0.99, 95% CI: 0.97, 1.02) [34]. For multiparas women, the threshold at which increased number of stressful life events increased the risk of preterm was five, and the relationship was statistically significant in 1990-1993 (aOR:1.07, 95% CI: 1.01,1.13), but not 1994-1995 (aOR:1.03, 95% CI: 0.98,1.09) [34]. The analysis was adjusted for maternal race, income from public aid, smoking status, parity, and pregnancy history.

Other studies

A 2003 study conducted between 1996 and 2000, not included in either systematic review mentioned above, recruited 1,962 women between 24 and 29 weeks' gestation in two prenatal clinics in North Carolina, to assess prospectively the relationship between stress and preterm birth [62]. Women were asked about stressful life events, social support, depression, pregnancy-related anxiety, and perceived stress. Women were also tested for the presence of bacterial vaginosis [62]. Perceived stress was assessed using a total count of the

woman's perception of the impact of life events, the count of the impact of events perceived as negative, the sum of pregnancy-related anxiety questions, perception of negative pregnancy-related events, the perception of discrimination (gender and racial) as well as perception on how safe their neighborhoods were. No association was found between a high number of stressful life events (aRR 0.9, 95% CI 0.6, 1.3), increased social support (aRR 0.9, 95% CI 0.6, 1.3), or depression (aRR 1.2, 95% CI 0.9, 1.5) and preterm birth after adjustment for maternal characteristics. However an association was reported between pregnancy-related anxiety and preterm birth (aRR 2.1, 95% CI 1.5, 3.0) as well as high levels of participant perceived negative impact stressful life events and preterm birth (aRR 1.8, 95% CI 1.2, 2.7). Women with pregnancy-related anxiety and the highest score of perceived negative impact life events also had an increased risk of preterm birth (aRR 3.0, 95% CI 1.7, 5.3), but no increased risk was found in women with a medium and low number of perceived negative events. Perceived high racial discrimination, adjusted for parity and poverty index but not racism was also associated with higher rates of preterm birth (aRR 1.4, 95% CI 1.0, 2.0) [63].

Another study, not included in either systematic review, but relevant for the relationship between stressful life events and adverse birth outcomes took place in China [64]. Researchers prospectively examined whether the timing of stress during gestation had differing effects on preterm birth and low birth weight. The researchers enrolled 3,316 women, of whom 1,800 met inclusion criteria (maternal age < 35, no history of abnormal prior pregnancy, no pregnancy complications including diabetes, hypothyroidism, stillbirth, medically

indicated preterm birth, or delivery after 32 weeks gestation). Women were asked 19 questions during the first, second, and third trimesters to assess the presence of stressful live events. Women were also asked to rate the impact of each event on their life from no impact (0) to extreme impact (4). Zhu et al. also used the constructs developed by Ahluwalia [35] to categorize the stressors for analysis. Women were also asked about levels of social support (categorized as low, medium low, medium high and high support) and coping style (lower negative coping (NC), medium low NC, medium high NC, and high NC). After adjusting for maternal demographics, behaviors, social support, and coping style, Zhu et al. reported an association between risk of preterm birth and the number of high impact stressful life events experienced during the first (aRR 2.4, 95% CI 1.13, 5.09) and second trimesters of pregnancy (aRR 2.86, 95% CI 1.32, 6.22) but not the third trimester.

In a separate study, Witt et al. examined the relationship between stressful life events experienced prior to conception (PSLE) and preterm birth in a sample of 9,350 infants born in 2001 participating in the Early Childhood Longitudinal Study, Birth Cohort [65]. The respondents in the study are infants' parents. PSLE included in the study were death of the either of the respondents parents, death of a previous live-born child, death of a spouse, divorce or separation from a partner, or fertility problems. Of the sample, 10.9% were preterm and 19.7% of the participants experienced at least one PSLE, with divorce or separation from partner the most common (10.4%). Adjusted analysis showed an increased odds of preterm birth among 15-19 year olds who had one or more PSLE compared to 15-19 year olds who did not (aOR 4.32, 95%CI 1.48, 12.61). PSLE was not

significantly associated with preterm birth within other age groups, though women 20-24 and 35+ who experienced a PSLE more than a year before conception had increased odds of delivering preterm compared to women in the referent age category (25-29) who were not exposed to a PSLE (aOR 1.62, 95%CI 1.08, 2.43). Women aged 30-34 did had a modestly elevated risk compared to the referent (aOR 1.44, 95% CI 0.98, 1.62).

Future research would benefit from clearer delineation of types of stress and refrain from direct comparison unless similar types of stress are measured. Research studies should assess perceived stress and coping styles as well as timing of the stressful life events. This information would enable scientists to examine stress and its mediators over the life course and their relationship with poor birth outcomes.

Professional Recommendations

Due to the prevalence of prenatal stress and its possible association with poor maternal and infant outcomes, in 2006, the American College of Obstetricians and Gynecologist (ACOG) published a Committee Opinion recommending that all pregnant women, regardless of socio-economic status, education level, or race/ethnicity, receive psychosocial screening during their prenatal visits, including screening for the presence of psychosocial stress (Committee Opinion 343). ACOG advises that multiple screenings occur during pregnancy, preferably at least one per trimester and further recommends that if a psychosocial issue is identified during screening, the physician should confirm the issue with the woman and provide follow-up counseling or referral services. Additionally, ACOG

suggests that physicians have a referral list of resources ready for in need patients [66].

Prevalence and Trends

Although many studies have assessed the relationship between prenatal or preconception stress and adverse pregnancy outcomes, few surveillance studies have examined current prevalence and trends in the prevalence of prenatal stress over time. The most recent population-based study assessing trends in prenatal stress in the United States used data from 11 states participating in the 1990-1995 PRAMS (Whitehead, 2003). Those authors found that 64% of women surveyed reported experiencing at least one stressful life event during pregnancy but noted that the average number of events women experienced declined by 0.18 events (0.03 events/year) over the 6 year period (Whitehead, 2003). It is unclear whether this trend has continued overtime. Prevalence and trends in prenatal stressful life events can be used by public health practitioners and clinicians to understand the need for screening and interventions to reduce stress among pregnant women. It may also shed light on how economic and social trends, such as financial recessions, may influence women's report of stressful life event. Therefore, in this study, we examined trends from 2000-2010 in prenatal SLEs and prevalence and risk factors for SLEs overall and by state using PRAMS data.

Chapter 2

Introduction

In 2010, 24% of American adults self-reported high levels of stress according to a 10-item perceived stress scale survey conducted nationally by the American Psychological Association [1]. A 2010 U.S. study among 1,522 pregnant women reported that 78% of women reported experiences of stress and 6% reported high stress experiences. Stress is associated with poor health outcomes in general [3], and some, but not all, studies have found an association between prenatal stress and adverse birth outcomes, such as preterm birth (<37 weeks gestational age), low birth weight, (<2500 grams) and small for gestational age (< 10th percentile in size for gestational age) [3, 4, 10, 11]. In addition, increased stress during pregnancy is associated with peripartum anxiety and depressive symptoms [67]. Due to the adverse pregnancy outcomes associated with prenatal stress, in 2006, the American College of Obstetricians and Gynecologist (ACOG) published a Committee Opinion recommending that all pregnant women, regardless of socio-economic status, education level or race/ethnicity, receive psychosocial screening during their prenatal visits, including screening for the presence of psychosocial stress [66].

Although many studies have assessed the relationship between prenatal or preconception stress and adverse pregnancy outcomes, few surveillance studies have examined trends over time in the prevalence of prenatal stress. The most recent population-based study assessing trends in prenatal stress in the United States used data from 11 states participating in the 1990-1995 Pregnancy Risk Assessment Monitoring System (PRAMS), a state-specific population-based

surveillance system of women's experiences before, during and after pregnancy [68]. Those authors found that 64% of women surveyed reported experiencing at least one stressful life event (SLE) during pregnancy and noted that the average number of events women experienced declined by 0.18 events over the 6 year period [68]. It is unclear whether this trend over time has continued and what the current prevalence of prenatal SLEs is among women. Understanding the current prevalence and trends in prenatal SLE can be used by public health practitioners and clinicians to determine the need for screening and interventions to reduce stress among pregnant women. Therefore, we examined trends from 2000-2010 in prenatal SLEs and prevalence and risk factors for SLEs overall and by state using PRAMS data.

Methods

PRAMS is a state-specific population-based surveillance system administered by the Centers for Disease Control and Prevention (CDC) in conjunction with participating state and New York City health departments. PRAMS collects self-reported information on maternal experiences and behaviors before, during, and after pregnancy among women who delivered a live infant. Collection occurs annually, and, as of 2010, 40 states and New York City participate, representing about 78% of all US births. Each participating state surveys via mail a stratified, systematic sample of 1,300 to 3,400 women identified from birth certificate data. Three attempts are made to contact the woman via standard mail. Up to 15 follow-up telephone calls are made to reach non-responders. The PRAMS protocol is approved by the CDC Institutional

Review Board (IRB) and each participant provides written informed consent. Response rates from states must exceed 65% to be reported; response rates for 2010 ranged from 65% in Alaska and West Virginia to 83% in Vermont.

The PRAMS survey asks if respondents experienced any of thirteen different SLEs during pregnancy. Based on previous research on how different SLEs correlate with one another [35], we grouped the 13 SLEs into four dichotomous constructs: 1) emotional stressors, such as the death or prolonged illness of close friends or family members; 2) financial stressors, such as personal and partner-related job loss, the inability to pay household bills, and moving to a new address; 3) partner-associated stressors, such as a divorce, arguing with a partner more than usual, and the partner expressing displeasure at the pregnancy; and 4) traumatic stressors, such as physical violence, incarceration, and homelessness. Women who reported yes to experiencing one or more of the individual stress questions were categorized as experiencing the construct. We examined individual SLEs, mean number of SLEs, and dichotomized the number of SLEs as (0 and ≥1).

Demographic characteristics assessed were maternal age (<25, 25-29 and ≥30), race and ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, Asian, and "other"), educational status (≤high school, some college, and ≥college), marital status (married, not married) and whether Medicaid had been used for prenatal care and/or delivery (yes, no). Information on maternal age, race/ethnicity, education level, and marital status was from the birth certificate. Information on Medicaid coverage for prenatal care and/or delivery was from the PRAMS survey.

Initially, we examined linear trends in demographic characteristics and SLEs from 2000 to 2010. For categorical variables, we assessed trends using logistic regression. For mean number of SLEs, we assessed trends using linear regression. We also assessed trends stratified by maternal demographics. In all models, year was included as a continuous, independent variable. Using data collected in 2010, we examined prevalence of SLEs (4 constructs and dichotomized as 0 or ≥1) and mean number of SLEs, by state and demographic characteristics. We assessed differences in prevalence using chi square tests and differences in mean number of SLEs using linear regression.

Ten states participated in PRAMS every year from 2000-2010 and had sufficient response rates for all years[a] (n=187,390 women). We excluded from all analyses women with missing response values for one or more SLE questions (n=6,488, 3.5%). Compared to the 180,902 women in the analytic sample, excluded women were more likely to be non-Hispanic African American or Hispanic, <25 years of age, less educated (high school or less), unmarried, and covered by Medicaid ($p<0.05$ for all). In 2010, response rates were $\geq$ 65% for 26 states[b] (n=38,255 women). Analyses using 2010 data only included women with information on all 13 PRAMS questions on SLEs (36,891 women; 96.4%). Compared to women in the analytic sample, the 1,364 (3.6%) excluded women were more likely to be non-Hispanic African American or Hispanic, <25 years of age, have some college education, be unmarried and covered by Medicaid

[a] Alaska, Arkansas, Colorado, Hawaii, Maine, Nebraska, Oklahoma, Utah, Washington and West Virginia

[b] Alaska, Arkansas, Colorado, Deleware, Georgia, Hawaii, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Utah, Vermont, Washington, West Virginia, and Wyoming

(p<0.05 for all). All analyses were weighted [69] to produce population-based estimates. Analysis was conducted in SUDAAN version 11.0 (Research Triangle, NC) to account for sampling design. Data cleaning was performed using SAS Enterprise Guide 4.3 (Cary, NC). The study was deemed exempt by the Emory Institutional Review Board prior to data analysis (Appendix A).

Results

For the trend analyses from 2000 to 2010, all demographic characteristics examined varied over time (Table 1). The percentage of both white and black mothers who had a live birth decreased from 72.3% and 5.8% in 2000 to 66.2% and 4.8% in 2010, respectively (p-trend < 0.05 for both). The percentage of Hispanic women in the sample increased from 13.0% in 2000 to 16.4% in 2010 (p-trend <0.01). The proportion of women classified as "other" race/ethnicity also increased from 2.8% in 2000 to 5.0% in 2010 (p-trend<0.05). The proportion of women younger than 25 years of age decreased from 37.7% in 2000 to 33.5% in 2010 (p-trend <0.01), while the proportion 25 to 29 years of age increased from 29.7% to 31.3% (p-trend <0.01). The prevalence of women 30 years and older also increased from 32.6% in 2000 to 35.2% in 2010 (p-trend=0.01). The proportion of women who had only a high school degree decreased from 49.6% to 42.0%, while the proportion of those who had some college or had completed college increased (p-trend <0.05 for all). The proportion of unmarried women increased from 27.3% to 31.1% (p-trend <0.05). The proportion of women covered by Medicaid rose from 30.1% in 2000 to 39.5% in 2010 (p-trend <0.01).

The self-reported prevalence of the four constructs of SLEs (financial, emotional, traumatic, partner-related) decreased significantly from 2000 to 2010 (Figure 1). Self-reported prevalence of financial stressors, unadjusted for demographics, increased significantly from 2008 (53.0%) to 2009 (55.0 %). However, overall, the unadjusted prevalence of self-reported financial SLEs decreased from 2000 (56.1%) to 2010 (53.4%). From 2000 to 2010, prevalence of emotional SLEs decreased from 32.5% to 29.3%, partner-related SLEs decreased from 33.5% to 30.0%, and traumatic SLEs decreased from 20.3% to 18.6%. For all years, financial stress was the most prevalent type, followed by emotional and partner-related stressors; traumatic stressors were reported least frequently.

Before adjustment for maternal characteristics, the prevalence of ten of the thirteen individual SLEs decreased significantly from 2000 to 2010 (Table 2). After adjusting for maternal age, race, education status, marital status, and Medicaid coverage, the prevalence of two additional SLEs, "You or your partner went to jail", and "Someone close to you had a problem with drinking or drugs" also decreased significantly from 2000 to 2010. The only individual SLE that did decline over time was "husband or partner job loss". The prevalence of women reporting zero SLEs increased from 24.5% in 2000 to 29.2% in 2010 ($p<0.05$). The prevalence of experiencing one to two and three to five SLEs did not change significantly over the decade, but the prevalence of experiencing six to 13 SLEs decreased significantly from 7.4% in 2000 to 5.8% in 2010 ($p<0.05$). Additionally, the mean number of prenatal SLEs declined from 2.07 (S.E. 0.03)

in 2000 to 1.83 (S.E. 0.02) in 2010 ($p<0.01$); a 0.03 (SE 0.00) annual decrease in the mean number of SLEs.

In 2010, the prevalence of SLE constructs, ≥1 SLE, and mean number of SLEs experienced during pregnancy varied by state (Table 3). For all states combined, 51.0% (CI: 50.1, 51.9) of women reported experiencing ≥1 financial SLE during pregnancy, with prevalence ranging from 42.2% in GA to 58.1% in OK. Of all women, 29.6% experienced ≥1 emotional SLEs during pregnancy, with prevalence ranging from 22.3% in GA to 40.0% in WV. Among all states combined, 28.5% reported experiencing ≥1 partner-related SLEs, but prevalence ranged from 22.7% in UT to 35.5% in AR. Only 17.6% of women reported experiencing ≥1 traumatic SLEs, but prevalence varied from 11.3% in NJ to 25.9% in WV. Overall, 70.2% of women self-reported experiencing ≥1 SLEs in 2010. Prevalence ranged from 58.5% in GA to 77.5% in WV. In 2010, the mean number of SLEs was 1.81 (0.02) overall, and ranged from 1.41 (0.05) in New York City to 2.26 (0.09) in OK.

In 2010, the prevalence of SLEs during pregnancy varied by the women's demographic characteristics (Table 4). Women who were married, were ≥30 years of age, had a college education or more, or had private insurance reported the lowest prevalence of all four types of SLEs and reported the lowest mean number of SLEs. Prevalence of all SLE decreased with increased age groups. No clear patterns emerged by race/ethnicity for prevalence and mean number of SLEs, though Asian/Pacific Islanders reported the lowest point prevalence for all constructs of SLE. Black women had the highest point prevalence of

emotional, traumatic and partner-related SLEs; however, the 95% CIs overlapped with other racial/ethnic groups. Mean number of SLEs also varied by demographic characteristics. Unmarried women had the highest mean number of SLE (2.48; SE: 0.04), and Asian/Pacific Islanders reported the lowest mean number of SLEs (1.11; SE: 0.04).

Discussion

We found that the prevalence and mean number of SLEs experienced in the 12 months prior to a live birth decreased slightly between 2000 and 2010, and the downward trend remained statistically significant after adjusting for women's demographic characteristics. However, even with a decrease over time, over 70% of women delivering a live birth in 2010 reported experiencing one or more SLEs, with financial SLEs the most commonly reported. In 2010, report of SLEs varied by state and demographic characteristics, with women in OK and WV, younger women, less educated women, unmarried women, and women covered by Medicaid reporting the highest number of SLEs.

From 2000-2010, we found a 0.03 (SE 0.00) annual decrease in the mean number of SLEs adjusted for maternal demographics. We also found decreases in 11 of 13 individual SLEs and all constructs, and the pattern remained after adjusting for maternal characteristics. Similar to our findings, Whitehead et al. reported that between 1990 and 1995, the average number of SLEs decreased by 0.03 events per year based on PRAMS data from 11 states. Those authors attributed the decrease in SLEs to economic trends and social changes over time. From 2000-2010, we found increases in the percentage of births to women 25 years and older and women with more than a high school

education, groups with lower prevalence of SLEs. However, we also found increases in the percentage of births to women covered by Medicaid, an indicator of low income, which is associated with a higher prevalence of SLEs. Thus, based on our data, it is unclear why there is a decreasing trend in prenatal SLEs despite demographic changes and economic trends that might predict and increase in SLEs.

Whitehead et al. reported that experiencing SLEs was common, with 64% of women reporting one or more SLEs during pregnancy between 1990 and 1995. This is lower than the 73.2% (95%CI 72.9, 73.5) of women who reported at least one SLE in our population (2000-2010). The discrepancy may be explained by the inclusion of different states in the sample and the absence of the question, "Did you move to a new address" in Whitehead's analysis, which is the most commonly reported SLE in our analysis (40% of women reported this SLE in 2010). After excluding the SLE on moving, the prevalence of experiencing ≥1 SLE in our sample was 62.9% (95%CI 62.6, 63.3), which is more consistent with Whitehead et al. They also found that the prevalence of experiencing one or more SLEs varied by maternal demographics, with low socioeconomic status the strongest predictor of experiencing an SLE. Similarly, we found that over 78% of women covered by Medicaid for prenatal care or delivery reported one or more SLEs, a significantly higher prevalence than privately insured women. Both the 1990-1995 study and the current study found that African American and Native American mothers, women under 25, women with high school attainment or less, and unmarried women were more likely to report six or more SLEs.

Increased stress may be associated with adverse pregnancy outcomes, including low birth weight, preterm birth [10, 11] and peripartum depression [8, 70]. However, current research supports the mediating effect of social support on the relationship between stress and adverse pregnancy outcomes. Therefore, public health efforts to identify and reduce stress among pregnant women may benefit their psychological and physical health. To this end, in 2006, the ACOG published a Committee Opinion recommending that all pregnant women, regardless of socio-economic status, education level, or race/ethnicity, receive psychosocial screening during their prenatal visits, including screening for the presence of psychosocial stress [66]. Additionally, ACOG recommends that physicians have a referral policy in place to mediate stress. However, it is unknown what percentage of prenatal care providers screens their patients for psychosocial stress, nor is it known whether screening and referral leads to reduced stress and improved health outcomes. Clinicians should be aware that while SLEs are especially prevalent among low income, younger, unmarried, and less educated women, we found the majority of women with a college education or higher (59.6%), with private insurance (64.2%), and who are married (64.2%), experience ≥ 1 SLE.

Our assessment of the prevalence and trends of SLEs is limited by the fact that PRAMS measures SLEs, rather than perceived stress. Additionally, PRAMS asks about 13 specific SLEs, while other unrecorded events may also contribute to a woman's stress levels. For instance, Dunkel-Schetter found that the strongest predictor of preterm birth was stress or anxiety related to the pregnancy [4]. Additionally, emerging research supports a life course model

where the accumulations of stress over a person's lifetime is more indicative of their risk of adverse pregnancy complications than the presence of an acute SLE during pregnancy [37]. For the trend analyses, we had data from only 10 states and, for the 2010 analyses, we had data from 26 states, which limits generalizability. PRAMS relies on self-reported, retrospective data, and women may not accurately report certain SLEs, especially sensitive ones, such as going to jail. PRAMS also asks about SLEs occurring in the 12 months before pregnancy. Therefore, some events could have occurred before conception so it is not possible to evaluate if any affect is due to events prior to conception or events that occur during pregnancy

In summary, we found that the majority of women in our sample experienced one or more SLE during pregnancy, although the prevalence of experiencing SLEs has decreased slightly over time. Prevalence of SLEs varied by state, and younger women, less educated women, unmarried women, and Medicaid-covered women had the highest prevalence of SLEs. Given the high prevalence of SLEs and their association with adverse pregnancy outcomes in other studies, more research is needed on how to reduce a woman's stress levels when a SLE occurs and whether screening and referral by prenatal care providers reduce women's stress levels and improves pregnancy outcomes.

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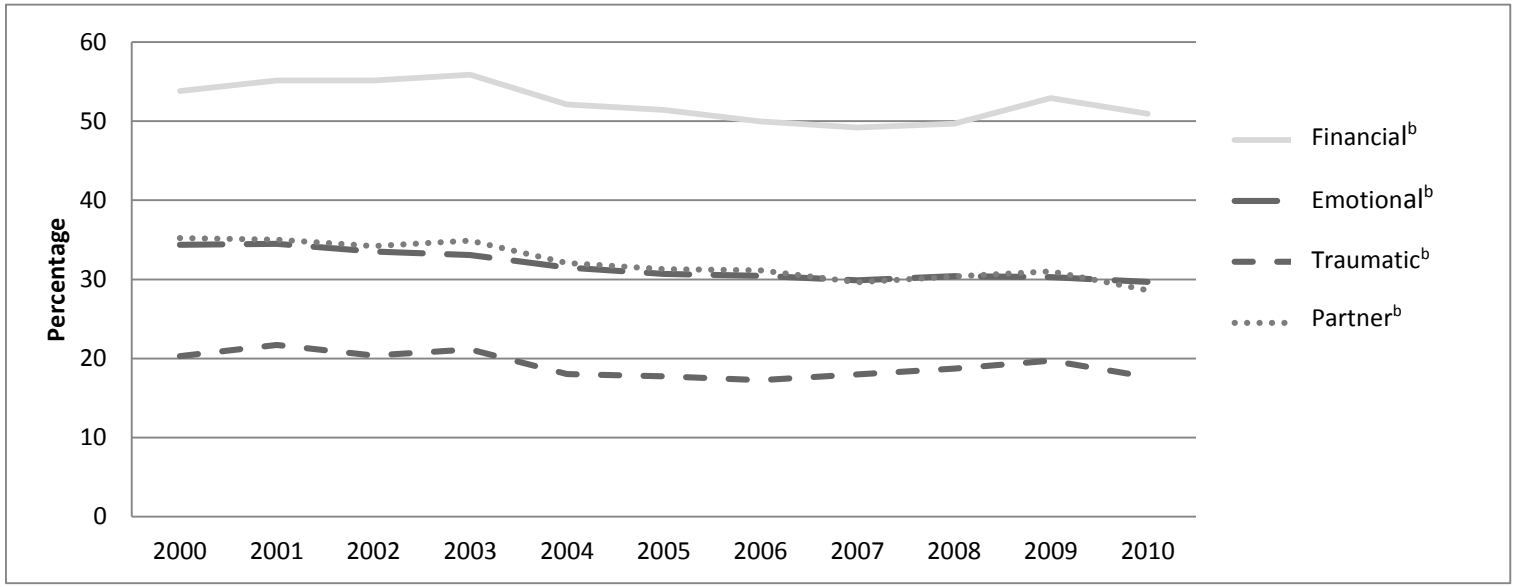
Table 1. Self-Reported demographic information among mothers who had live births by maternal characteristics --- Pregnancy Risk Assessment Monitoring System (PRAMS), 10[a] states 2000-2010

Maternal Demographics	2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		p-value
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	Trend[b]
Age group																							
<25	37.7	36.6, 38.9	39.4	38.2, 40.5	38.6	37.4,39.7	38.9	37.7, 40.0	36.5	35.4, 37.7	37.4	36.2, 38.6	35.9	34.8, 37.1	35.4	34.3, 36.5	35.4	34.3, 36.5	35.4	34.2, 36.6	33.5	32.3, 34.6	<0.01↓
25-29	29.7	28.6, 30.8	27.0	26.0, 28.0	27.5	26.4, 28.6	28.3	27.2, 29.4	29.1	27.9, 30.2	28.8	27.7, 29.8	29.7	28.6, 30.8	31.0	29.8, 32.2	30.9	29.8, 32.0	30.9	29.8, 32.0	31.3	30.1, 32.4	<0.01↑
≥30	32.6	31.4, 33.7	33.6	32.5, 34.8	33.9	32.7, 35.0	32.8	31.7, 33.9	34.4	33.3, 35.6	33.8	32.7, 35.0	34.4	33.2, 35.5	33.6	32.5, 34.7	33.7	32.6, 34.8	33.7	32.6, 34.8	35.2	34.1, 36.4	0.01↑
Race/ethnicity																							
NH White	72.3	71.4, 73.0	72.3	71.5, 73.1	70.5	69.6, 71.3	69.8	68.9, 70.7	68.8	67.8, 69.7	68.5	67.5, 69.4	68.4	67.5, 69.3	67.8	66.9, 68.7	67.6	66.7, 68.4	66.2	65.3, 67.1	66.9	66.0, 67.8	<0.01↓
NH Black	5.8	5.2,6.3	5.2	4.7, 5.6	5.5	5.1, 6.0	4.8	4.4, 5.3	5.3	4.7, 5.8	4.8	4.3,5.2	5.4	4.9, 5.9	4.9	4.5, 5.30	5.1	4.6, 5.5	4.9	4.5, 5.4	4.8	4.4, 5.3	0.02↓
Hispanic	12.8	12.1,13.5	13.5	12.8, 14.4	14.3	13.6, 15.0	15.2	14.4, 15.9	15.6	14.9, 16.4	16.2	15.5, 17.0	15.9	15.2, 16.7	16.5	15.7, 17.2	16.6	15.8, 17.3	16.9	16.2, 17.7	16.4	15.6, 17.1	<0.01↑
Asian/Pacific Islander	6.4	6.1, 6.6	6.5	6.3, 6.8	6.8	6.5, 7.1	6.4	6.1, 6.7	6.9	6.5, 7.2	6.4	6.1, 6.7	6.2	5.9, 6.4	6.5	6.2, 6.8	6.6	6.3, 6.9	6.5	6.2, 6.9	6.9	6.5, 7.2	0.37
Other	2.8	2.5, 3.1	2.5	2.4, 2.8	2.9	2.5, 3.2	3.7	3.2, 4.2	3.5	3.1, 3.9	4.1	3.6, 456	4.1	3.6, 4.5	4.3	3.9, 4.8	4.2	3.7, 4.6	5.4	4.9, 5.9	5.0	4.5, 5.5	<0.01↑
Education																							
≤HS	49.6	48.4, 50.8	51.1	50.0, 52.3	50.7	49.5, 51.9	50.7	49.5, 51.9	48.5	47.3, 49.6	49.0	47.8, 50.1	47.9	46.7, 49.0	46.9	45.8, 48.1	47.1	45.9, 48.2	44.1	43.0, 45.3	42.0	40.9,43.1	<0.01↓
Some college	24.3	23.2, 25.4	22.9	22.0, 23.9	22.7	21.7, 23.7	23.7	22.6, 24.7	24.2	23.2, 25.3	24.7	23.7, 25.8	24.7	23.6, 25.7	25.0	24.0, 26.1	24.8	23.8, 25.9	27.9	26.8, 29.0	28.9	27.8, 30.0	<0.01↑
≥College	26.1	25.1, 27.2	25.9	24.9, 26.9	26.6	25.5, 27.7	25.6	24.6, 26.6	27.3	26.2, 28.4	26.3	25.3, 27.4	27.5	26.4, 28.5	28.0	27.0, 29.1	28.1	27.1, 29.2	28.0	26.9, 29.1	29.1	28.0, 30.2	<0.01↑
Married																							
Yes	72.7	71.6, 73.8	72.4	71.4, 73.5	71.5	70.4, 72.6	70.9	69.7, 72.0	70.8	69.7, 72.0	69.7	68.6, 70.8	69.3	68.2, 70.4	68.9	67.8,69.9	67.6	66.5, 68.7	67.4	66.3, 68.5	68.9	67.8, 70.0	<0.01↓
Medicaid																							
Yes	30.1	29.0, 31.1	31.1	30.0,32.1	33.4	32.3,34.5	35.6	34.4, 36.7	38.8	37.6, 40.0	40.6	39.4, 41.7	39.2	38.0, 40.3	39.4	38.2, 40.5	40.3	39.1, 41.4	39.9	38.8, 41.1	39.5	38.4, 40.7	<0.01↑

[a] Alaska, Arkansas, Colorado, Hawaii, Maine, Nebraska, Oklahoma, Utah, Washington and West Virginia
[b] Arrow indicates direction of trend over time

Figure 1. Trends from 2000 to 2010 in prevalence of self-reported prenatal stressful life events among mothers who had live births--Pregnancy Risk Assessment Monitoring System (PRAMS), 10 states[a]



[a] Alaska, Arkansas, Colorado, Hawaii, Maine, Nebraska, Oklahoma, Utah, Washington and West Virginia
[b] P-value for trend <0.05

Table 2. Self-Reported prevalence of individual, cumulative number, and mean number of stressful life events among mothers who had live births --- Pregnancy Risk Assessment Monitoring System (PRAMS), 10 states 2000-2010

Stressor	2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2010	
	%	95 CI	%	95 CI	%	95 CI	%	95 CI	%	95 CI	%	95 CI	%	95 CI	%	95 CI	%	95 CI	%	95 CI	%	95 CI
Someone close hospitalized[ab]	25.9	24.8, 27.0	26.9	25.8, 28.0	25.4	24.4, 26.5	25.7	24.7, 26.8	25.4	24.3, 26.5	23.5	22.5, 24.5	23.5	22.4, 24.5	24.0	23.0, 25.1	24.2	23.2, 25.2	23.2	22.2, 24.3	22.8	21.8, 23.9
Separated or divorced[ab]	10.0	9.2, 10.8	9.6	8.9, 10.3	9.5	8.8, 10.2	9.9	9.1, 10.6	9.0	8.3, 9.7	9.3	8.5, 10.0	8.9	8.2, 9.6	9.3	8.6, 10.0	8.4	7.8, 9.1	7.8	7.1, 8.5	7.8	7.2, 8.5
Moved[ab]	40.4	39.4, 41.8	40.5	39.3, 41.7	40.4	39.2, 41.6	40.6	39.4, 41.8	40.0	38.8, 41.2	39.9	38.7, 41.1	40.2	39.0, 41.4	39.2	38.0, 40.4	38.6	37.4, 39.8	38.0	36.8, 39.2	37.0	35.8, 38.2
Homeless[ab]	4.0	3.5, 4.5	4.8	4.3, 5.4	4.5	4.0, 5.0	4.9	4.4, 5.5	3.4	3.0, 3.9	3.0	2.6, 3.4	3.7	3.2, 4.1	3.3	2.8, 3.7	3.3	2.8, 3.7	3.5	3.0, 4.0	2.7	2.3, 3.1
Job loss-partner	11.9	11.1, 12.7	13.8,	12.9, 14.6	16.9	16.0, 17.9	15.7	14.8, 16.6	13.6	12.7, 14.4	12.6	11.8, 13.5	12.5	11.6, 13.3	11.6	10.8, 12.4	13.4	12.6, 14.2	15.6	14.6, 16.5	14.5	13.6, 15.4
Job loss-self[ab]	9.6	8.9,10.3	10.5	9.8, 11.3	11.1	10.4, 11.9	11.1	10.4, 11.9	9.5	8.8, 10.3	8.7	8.0, 9.4	8.5	7.8, 9.2	8.4	7.7, 9.1	9.2	8.5, 9.9	11.0	10.2, 11.8	9.4	8.5, 9.9
Increased arguments with partner[ab]	27.6	26.5,28.7	26.6	25.5, 27.6	26.5	25.5, 27.6	26.4	23.3, 27.5	24.7	23.7, 25.8	25.2	24.1, 26.2	25.8	24.7, 26.8	24.2	23.2, 25.2	25.2	24.1, 26.2	23.7	22.6, 24.8	22.4	21.4, 23.4
Partner didn't want pregnancy[ab]	9.8	9.1, 10.6	9.7	8.9, 10.4	9.5	8.7, 10.2	8.8	8.1, 9.5	8.5	7.8, 9.2	8.3	7.6, 9.0	8.2	7.5, 8.9	7.5	6.9, 8.1	8.2	7.5, 8.9	8.0	7.3, 8.7	6.5	5.9, 7.2
Unpaid bills[ab]	26.7	25.6, 27.8	27.6	26.5, 28.6	26.1	25.0, 27.2	27.3	26.2, 28.3	23.9	22.9, 25.0	23.6	22.6, 24.6	23.1	22.0, 23.1	22.8	21.8, 23.9	23.2	22.2, 24.2	23.2	22.1, 23.2	21.8	20.8, 22.8

Table Continues on following page

[a] Unadjusted p-value for trend is significant and downward
[b] Adjusted p-value for trend is significant and downward

Physical fight[ab]	4.3	3.9, 4.8	4.9	4.4, 5.5	4.3	3.8, 4.8	3.9	3.5, 4.4	3.4	3.0, 3.9	3.9	3.4, 4.3	4.0	3.5, 4.5	3.8	3.3, 4.2	3.6	3.2, 4.1	3.5	3.1, 3.9	3.3	2.9, 3.8
You/partner went to jail[b]	4.7	4.2, 5.3	5.3	4.7, 5.8	4.8	4.3, 5.3	4.7	4.3, 5.3	4.6	4.2, 5.2	4.5	4.0, 5.0	4.6	4.1, 5.1	4.6	4.1, 5.1	5.1	4.6, 5.7	4.4	3.9, 4.9	4.4	3.9, 4.9
Someone close had a drinking/drug problem[b]	14.3	13.4, 15.1	14.2	13.4, 15.1	14.0	13.2, 14.9	14.2	13.4, 15.1	13.1	12.3, 14.0	13.9	13.0, 14.8	13.3	12.5, 14.2	13.8	13.0, 14.6	13.7	12.8, 14.5	13.7	12.9, 14.6	14.0	13.2, 14.9
Someone very close to me died[ab]	17.7	16.8, 18.6	18.5	17.5, 19.4	17.7	16.8, 18.6	18.0	17.1, 18.9	17.0	16.1, 17.9	16.3	15.4, 17.2	16.8	15.9, 17.7	17.6	16.6, 18.5	17.5	16.6, 18.4	16.7	15.8, 17.7	16.4	15.5, 17.2
Number of Stressors																						
0[ab]	24.6	23.5, 25.6	24.2	23.2, 25.3	24.4	23.3, 25.4	23.9	22.9, 24.9	26.5	25.4, 27.6	27.3	26.3, 28.4	28.5	27.4, 29.6	28.8	27.7, 29.9	29.2	28.1, 30.3	27.3	26.3, 28.4	29.4	28.3,30.5
1-2	43.0	41.8, 44.2	42.1	41.0, 43.3	41.4	40.2, 42.6	41.9	40.7, 43.1	42.6	41.1, 43.9	42.0	40.8, 43.2	41.6	40.4, 42.8	41.9	40.6, 43.1	40.4	39.2, 41.6	42.8	41.6, 44.0	42.1	40.9, 43.3
3-5[ab]	25.1	24.1, 26.2	25.8	24.7, 26.8	26.6	25.5, 27.7	26.6	25.5, 27.7	24.2	23.2, 25.3	24.8	23.8, 25.9	23.1	22.0, 24.1	23.1	22.0, 24.1	23.8	22.7, 24.8	23.8	22.8, 24.9	22.8	21.8, 23.9
6-13[ab]	7.3	6.7, 8.0	7.9	7.2, 8.5	7.7	7.0,8.3	7.6	6.9, 8.2	6.6	6.0, 7.2	5.8	5.2, 6.4	6.9	6.3, 7.5	6.3	5.7, 6.9	6.7	6.1, 7.3	6.0	5.4, 6.7	5.6	5.1, 6.2
Mean (SE)[ab]	2.07	0.03	2.13	0.03	2.11	0.03	2.11	0.02	1.96	0.03	1.93	0.02	1.93	0.02	1.90	0.02	1.94	0.03	1.92	0.03	1.83	0.02

[a] Unadjusted p-value for trend is significant

[b]Adjusted p-value for trend is significant and downward

Table 3. Self-Reported prevalence of prenatal stressful life events, among mothers who had live births by site -- Pregnancy Risk Assessment Monitoring System (PRAMS), 26 states[9] and New York City, 2010

State	Financial		Emotional		Traumatic		Partner		≥1		
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	Mean (se)
Alaska	49.6	45.9, 53.3	26.5	23.3, 29.7	21.0	18.0, 24.0	26.6	23.4, 29.9	68.7	65.2, 72.1	1.73, (0.07)
Arkansas	57.1	53.7, 60.5	35.9	32.6, 39.2	25.9	22.9 29.0	35.5	31.3, 37.8	78.7	75.8, 81.5	2.22, (0.07)
Colorado	53.3	50.2, 56.4	29.5	25.7, 31.3	16.4	14.0, 18.7	25.3	22.6, 28.0	70.1	67.7, 73.4	1.74, (0.06)
Delaware	49.9	46.8, 52.9	31.7	28.9, 34.5	18.1	15.7, 20.4	29.0	26.3, 31.8	71.4	68.7, 74.2	1.83, (0.06)
Georgia	42.2	37.3, 47.0	22.3	18.2, 26.3	14.1	10.6, 17.6	24.3	19.8, 28.2	57.5	52.7, 62.3	1.55, (0.11)
Hawaii	49.1	45.9, 52.3	24.9	22.2, 27.7	13.4	11.2, 15.6	26.6	24.3, 30.0	64.4	61.3, 67.5	1.56, (0.06)
Maine	56.5	53.0, 60.1	34.0	30.6, 37.4	21.3	18.3, 24.3	27.3	24.1, 30.6	74.5	71.5, 77.6	2.05, (0.07)
Maryland	50.4	45.6, 54.4	28.9	25.2, 32.6	16.0	13.0, 19.1	27.8	24.1, 31.5	69.3	66.6, 73.0	1.80, (0.08)
Massachusetts	50.5	46.9, 54.1	30.8	27.4, 34.2	16.1	13.5, 18.8	26.6	23.5, 29.7	70.5	67.3, 73.8	1.73, (0.06)
Michigan	53.0	50.0, 56.1	34.1	31.2, 37.0	19.2	16.8, 21.7	31.4	28.3, 34.3	73.8	71.1, 76.5	1.92, (0.06)
Minnesota	47.4	44.4, 50.4	26.6	24.0, 29.2	15.4	13.2, 17.5	25.0	22.4, 27.6	65.4	62.6, 68.2	1.55, (0.05)
Missouri	57.0	54.0, 60.0	33.0	30.2, 36.0	20.2	17.6, 22.7	31.9	29.0, 34.9	74.6	71.9, 77.2	2.07, (0.06)
Nebraska	50.0	47.3, 52.8	26.4	23.9, 28.9	15.1	13.1, 17.1	25.3	22.9, 27.7	68.2	66.6, 70.8	1.64, (0.05)
New Jersey	48.5	45.7, 51.4	29.8	27.1, 32.4	11.3	9.9, 13.3	26.7	24.2, 29.2	68.3	66.7, 71.0	1.62, (0.05)
New York	50.6	46.7, 54.5	30.7	27.1, 34.3	18.0	14.9, 21.2	27.9	24.3, 31.4	70.0	67.4, 73.6	1.76, (0.08)
Ohio	52.0	48.3, 55.7	35.9	32.3, 39.4	21.0	18.0, 24.1	31.7	28.3, 35.1	73.7	70.5, 77.0	2.11, (0.08)
Oklahoma	58.1	54.3, 61.8	33.4	29.8, 36.9	24.0	21.0, 27.7	32.9	29.2, 36.5	74.3	71.0, 77.7	2.26, (0.09)
Oregon	56.7	53.3, 60.0	27.6	24.5, 30.7	19.9	17.2, 22.7	25.8	22.8 28.7	71.2	68.1, 74.2	1.95, (0.07)
Pennsylvania	45.9	42.3, 49.4	33.7	30.4, 37.1	17.3	14.4, 20.1	28.3	25.0, 31.6	71.9	68.7, 74.5	1.77, (0.07)
Rhode Island	48.8	45.6, 52.1	30.0	27.0, 32.9	17.5	14.9, 20.2	27.9	24.9, 30.9	71.5	68.6, 74.5	1.77, (0.06)
Texas	54.7	51.6, 57.7	28.6	25.9, 31.4	19.1	16.7, 21.5	32.1	29.2, 34.9	73.3	70.6, 76.0	1.92, (0.06)
Utah	50.1	47.3, 52.9	26.5	24.0, 29.0	14.8	12.9, 16.7	22.7	20.4, 25.0	67.2	64.5, 69.8	1.54, (0.05)
Vermont	51.8	48.8, 54.9	30.2	27.4 33.0	19.5	17.0, 21.9	27.9	25.1, 30.6	69.2	66.4, 72.0	1.85, (0.06)
Washington	52.4	49.1, 55.7	25.6	22.7, 28.5	15.9	13.5, 18.4	23.9	21.0, 26.7	67.2	64.1, 70.3	1.66, (0.06)
West Virginia	56.5	53.3, 59.7	40.0	36.9, 43.2	25.9	23.0, 28.7	29.7	26.6, 32.5	77.5	74.8, 80.2	2.23, (0.07)
Wyoming	52.8	49.1, 56.4	26.9	23.6, 30.1	18.1	15.3, 20.9	26.3	23.1, 29.5	70.6	67.3, 73.9	1.72, (0.06)
New York City	43.1	39.8, 46.4	23.9	21.1, 26.7	13.2	10.9, 15.5	25.9	22.9, 28.8	64.8	61.6, 68.0	1.41, (0.05)
Total	51.0	50.1, 51.9	29.6	28.8, 30.4	17.6	16.9, 18.3	28.5	27.7, 29.4	70.2	69.3, 71.0	1.81 (0.02)

Abbreviation: CI = confidence interval.

[a] Alaska, Arkansas, Colorado, Deleware, Georgia, Hawaii, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Utah, Vermont, Washington, West Virginia, and Wyoming

Table 4. Self-Reported prevalence of prenatal stressful life events among mothers who had live births, by maternal demographic characteristics--- Pregnancy Risk Assessment Monitoring System (PRAMS), 26 states[a] and New York City, 2010

Maternal	Financial		Emotional		Traumatic		Partner		≥1		
Demographics	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	Mean (se)
Age group[b,c,d,e,f]											
<25	62.2	60.5, 63.9	33.2	31.6, 34.8	27.4	25.9, 28.9	40.6	38.6, 42.0	80.0	78.6, 81.5	2.43 (0.04)
25-29	51.6	49.9, 53.3	28.4	26.9, 29.9	15.7	14.5, 17.0	24.7	23.6, 26.5	69.5	67.9, 71.1	1.72 (0.03)
≥30	41.8	40.4, 43.2	27.7	26.4, 29.0	11.2	10.3, 12.2	21.8	20.9, 23.2	63.0	61.6, 64.3	1.38 (0.02)
Race/ethnicity[b,c,d,e,f]											
NH White	48.2	47.0, 49.3	30.9	29.8, 31.9	16.0	15.2, 16.9	25.1	24.1, 26.1	68.5	67.4, 69.5	1.70 (0.02)
NH Black	57.6	55.3, 60.0	32.9	30.7, 35.0	23.0	21.0, 24.9	41.7	39.4, 44.0	76.5	74.4, 78.6	2.32 (0.06)
Hispanic	55.7	53.2, 58.2	26.7	24.5, 28.9	20.7	18.6, 22.7	30.7	28.4, 33.0	73.9	71.7,76.1	1.92 (0.05)
Asian/Pacific Islander	42.1	38.9, 45.4	18.4	15.9, 20.8	5.4	4.1, 6.6	21.3	18.5, 24.0	56.9	53.6, 60.3	1.11 (0.04)
Other	58.7	54.1, 63.2	30.7	26.7, 34.7	21.3	17.7, 24.8	31.6	27.5, 35.7	73.1	69.1, 77.6	2.04 (0.10)
Education[b,c,d,e,f]											
≤HS	57.5	56.0, 59.0	30.0	28.7, 31.4	24.2	22.9, 25.5	34.9	33.5, 36.4	75.6	74.3, 76.9	2.16 (0.03)
Some college	56.0	54.2, 57.7	32.2	30.6, 33.8	18.5	17.2, 19.9	31.5	29.9, 33.1	73.7	72.1, 75.2	2.01 (0.03)
≥College	37.4	35.9, 38.9	26.8	25.4, 28.2	7.5	6.7, 8.4	16.8	15.6, 18.0	59.6	58.0, 61.1	1.32 (0.02)
Marital Status[b,c,d,e,f]											
Married	44.4	43.3, 45.5	28.0	26.9, 29.0	10.9	10.1, 11.9	19.5	18.6, 20.4	64.2	63.1, 65.2	1.38 (0.02)
Not Married	61.3	59.8, 62.8	32.1	30.7, 33.7	28.1	26.8, 29.5	42.6	41.1, 44.2	79.6	78.3,80.9	2.48 (0.04)
Insurance status[b,c,d,e,f]											
Medicaid	63.1	61.6, 64.6	31.2	29.8, 32.6	25.9	24.6, 27.2	38.1	36.6, 39.6	78.7	77.5, 80.0	2.41 (0.03)
Not Medicaid	42.4	41.3, 43.6	28.5	27.4, 29.6	11.7	10.9, 12.5	21.7	20.8, 22.7	64.2	63.1, 65.3	1.38 (0.02)

Abbreviation: CI = confidence interval.

[a]Alaska, Arkansas, Colorado, Deleware, Georgia, Hawaii, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Utah, Vermont, Washington, West Virginia, and Wyoming

[b]Chi-square value p ≤0.05 for relationship of selected maternal demographic with prevalence of emotional stressors

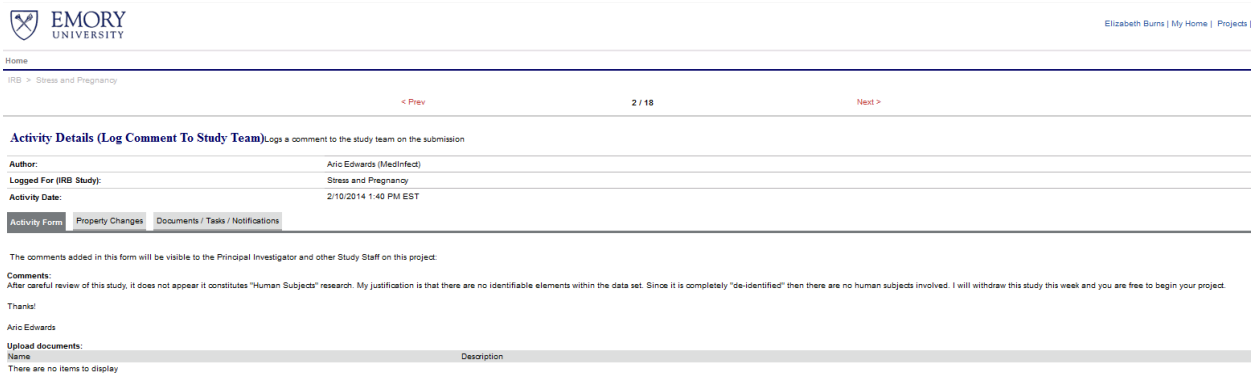
[c] Chi-square value p ≤0.05 for relationship of selected maternal demographic with prevalence of financial stressors

[d]Chi-square value p ≤0.05 for relationship of selected maternal demographic with prevalence of traumatic stressors

[e] Chi-square value p≤0.05 for relationship of selected maternal demographic with prevalence of partner related stressor

[f]p≤0.05 for difference in mean by ANOVA

Appendix A



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Activity Details (Log Comment To Study Team) Logs a comment to the study team on the submission

Author:	Aric Edwards (MedInfect)
Logged For (IRB Study):	Stress and Pregnancy
Activity Date:	2/10/2014 1:40 PM EST

Activity Form | Property Changes | Documents / Tasks / Notifications

The comments added in this form will be visible to the Principal Investigator and other Study Staff on this project:

Comments:
After careful review of this study, it does not appear it constitutes "Human Subjects" research. My justification is that there are no identifiable elements within the data set. Since it is completely "de-identified" then there are no human subjects involved. I will withdraw this study this week and you are free to begin your project.

Thanks!

Aric Edwards

Upload documents:

Name	Description
There are no items to display	