



The Impact of Psychosocial Stress on Maternal Health Outcomes: A Multi-State PRAMS 8 (2016-2018) Analysis

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## Abstract

**Introduction:** Significant racial disparities persist in maternal morbidity rates, disproportionately affecting Black women. Experiencing high levels of stress during pregnancy is associated with increased risk for preterm birth, infant mortality, and preeclampsia. This study investigates the impact of psychosocial life stressors on maternal morbidity and racial disparities utilizing the Pregnancy Risk Assessment Monitoring System (PRAMS) dataset.

**Methods:** Participants (N=24,209) included were from Phase 8 (2016-2018) of the PRAMS survey across five states. Stressors were grouped into traumatic, partner-related, financial, or emotional. Maternal outcomes included gestational diabetes, hypertensive disorders of pregnancy, prenatal depression, and postpartum depression. The association between life stressors and maternal morbidity was evaluated using modified Poisson regression models with robust error variance to estimate adjusted prevalence ratios.

**Results:** Black women were more likely to report all stressors, and Hispanic women had an increased prevalence of partner-related and financial stressors. Experiencing any maternal morbidity was associated with partner (38.0% versus 22.0%;  $p<0.001$ ), trauma (20.9% versus 10.9%;  $p<0.001$ ), financial (40.5% versus 25.7%;  $p<0.001$ ), and emotional stress (36.4% versus 28.3%;  $p<0.001$ ). Compared to mothers who reported no stressors, mothers who reported 1-3 stressors, 4-6 stressors, and  $\geq 7$  stressors had a 1.14, 1.38, and 1.45 higher adjusted prevalence ratio of maternal morbidity, respectively.

**Conclusions/Implications:** Psychosocial stress has a substantial impact on maternal outcomes. Pregnant women should be screened and connected with resources to alleviate the burden of their respective stressful life events.

## Keywords

psychosocial stress; maternal health; maternal morbidity; PRAMS; pregnancy

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### **ABSTRACT**

**Introduction:** Significant racial disparities persist in maternal morbidity rates, disproportionately affecting Black women. Experiencing high levels of stress during pregnancy is associated with increased risk for preterm birth, infant mortality, and preeclampsia. This study investigates the impact of psychosocial life stressors on maternal morbidity and racial disparities utilizing the Pregnancy Risk Assessment Monitoring System (PRAMS) dataset.

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## INTRODUCTION

The maternal mortality rate in the United States (U.S.) is the highest of any industrialized country (Tikkanen et al., 2020). Non-Hispanic Black women are 3.2 times more likely to die from complications of childbirth than non-Hispanic white women; hereafter referred to as Black and white women respectively (Creanga et al., 2015; Tikkanen et al., 2020). Similarly, Black women are more likely to experience severe maternal morbidity (SMM), which are unexpected physical and psychological outcomes in pregnancy, labor and delivery that result in detrimental health outcomes to a mother's health (*American College of Obstetricians and Gynecologists and the Society for Maternal-Fetal Medicine*, 2016; Noursi et al., 2021). SMM is closely related to maternal mortality as it involves conditions that, if left untreated, could result in death. Recent data on pregnancy-related mortality in the U.S. shows that Black women across seven states have 2.1 times greater incidence of SMM than white women (Creanga et al., 2014).

Stress can be operationalized based on biomedical, psychological, sociological, and environmental perspectives (Beutel et al., 2018). Stress induced by psychosocial factors is termed as psychosocial stress. It involves stress affiliated with social situations such as social threats, events, evaluations, exclusions, achievements, and relationships (Kogler et al., 2015). Types of psychosocial stressors include major life events, trauma, chronic strain, day-to-day hassles, and perceived stress due to loneliness, marital discord, experiences of discrimination, work stress, financial strain, or neighborhood safety and cohesion (Beutel et al., 2018; Crosswell & Lockwood, 2020).

Psychosocial stress during pregnancy often results in physiological and psychological changes that can increase risk for adverse obstetric outcomes (Witt et al., 2014; Woods et al., 2010). Stressful life events, or major life stressors, are psychosocial stressors that are uncontrollable, undesired, or unscheduled events that are discrete and observed with a clear beginning and ending point that show a major change in life (Michael et al., 2009). The literature on maternal psychosocial stress and obstetric outcomes shows that major life stressors contribute to adverse maternal health outcomes (Littleton et al., 2010; Witt et al., 2014). Physiologically, stress results in the release of vasoconstricting hormones that elevate blood pressure, and can cause hypertension, preeclampsia, heart disease and other risk factors of SMM (Coussons-Read, 2013; Kulkarni et al., 1998; *Maternal, 2015.; Stress and Pregnancy*, 2019; S. Zhang et al., 2013). Hypertension and preeclampsia are two of the main causes of maternal and perinatal morbidity and mortality.

Women who experience high levels of stress during pregnancy have 25-60% higher risk for preterm delivery than those who do not (*Maternal Stress*, 2015.; Wadhwa et al., 2011). Previous studies have also shown associations between maternal stress and increased risk of infant mortality and low birth weight (Lima et al., 2018; *Maternal Stress*, 2015; Stylianou-Riga et al., 2018). Stress reported before and during pregnancy is linked with low birth weight independent of preterm delivery (*Maternal Stress*, 2015). Life stressors during pregnancy may also influence eating behaviors which could increase blood glucose levels leading to the development of gestational diabetes mellitus and high blood pressure during pregnancy, putting one at increased risk for preeclampsia (*Maternal Stress*, 2015). Additionally, stress can impact responses to situations and lead to unhealthy behaviors such as over or under eating, smoking, drinking alcohol, and using

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drugs, which can lead to serious health problems for both mother and fetus (Coussons-Read, 2013; *Stress*, 2006.; *Maternal Stress*, 2015.; *Stress and Pregnancy*, 2019). Stressful life events, including intimate partner violence (IPV), neighborhood homicide, and natural disasters, lead to adverse mental health outcomes during pregnancy (de Mendoza et al., 2018). Women who experience partner-related or financial-related chronic stress may be more inclined to face postpartum depression (Qobadi et al., 2016).

Current literature shows that there are notable racial disparities in exposure to psychosocial stress and adverse maternal outcomes (Giurgescu & Misra, 2018; Grobman et al., 2018; Howell, 2018; Lu & Chen, 2004; Manuck, 2017). Black women have a 2-fold greater risk for preterm birth compared with white women (Manuck, 2017). Black women are additionally more likely to experience hypertensive diseases of pregnancy, preterm birth, have a low birth weight infant, and experience various forms of psychosocial stressors compared to white women (Grobman et al., 2018; Howell, 2018). Compared to white women, pregnant Black women are more likely to live in disadvantaged neighborhoods, experience racial discrimination or psychological stress, suffer from depression or depressive symptoms, showcase avoidance coping mechanisms, and report lower levels of social support (Giurgescu & Misra, 2018). Even after controlling for sociodemographic differences, one study found that Black women are 163% more likely to experience partner-associated stress before and during pregnancy than white women (Lu & Chen, 2004).

Over the past few decades, several studies have examined the relationship between psychosocial stressors and maternal health outcomes using data from the Pregnancy Risk Assessment Monitoring System (PRAMS). However, most of these studies are state specific and do not assess geographic disparities in psychosocial stressors (Farr et al., 2014; Morgan et al., 2020; Smith et al., 2015; Stone et al., 2015). In addition, in a 2004 study that utilized PRAMS data from 19 states, the analysis was restricted to the role of stressful life events in preterm birth (Lu & Chen, 2004). Thus, there is a paucity of recent literature utilizing multistate PRAMS data to understand the role of various types of stressful life events on adverse physiological and psychological maternal outcomes. In the United States, maternal morbidity and SMM rates vary by state. The present study seeks to fill this gap by utilizing PRAMS data from states which had low (Connecticut and Massachusetts), moderate (Wisconsin), and high (Louisiana and Missouri) maternal mortality rates in 2019 compared to the national average; to identify sources of stress which predispose women to gestational diabetes, hypertensive disorders of pregnancy, prenatal depression, and postpartum depression. In addition, the study aims to further elucidate disparities in maternal experiences of major life stressors and identify women at increased risk for maternal morbidity.

## **METHODS**

### **Participants and Procedures**

This study includes mothers who participated in Phase 8 of the Pregnancy Risk Assessment Monitoring System (PRAMS) survey across five states (Connecticut, Louisiana, Massachusetts, Missouri, and Wisconsin) between 2016 and 2018. PRAMS is a multistate, population-based surveillance system funded by the Centers for Disease Control and Prevention (CDC) in collaboration with state health departments. The PRAMS survey uses standardized data collection methods and consists of: Core questions (CDC required questions to allow for multistate analysis), Standard questions (CDC-approved question list from which states can select additional

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questions), and State-developed questions (questions developed by individual states). PRAMS collects data on maternal experiences and behaviors that occur before, during, and after pregnancy as well as in early infancy. Details of PRAMS methodology and protocols have been published elsewhere (*PRAMS Methodology* 2021). Participants are randomly selected between 2-6 months postpartum from state birth certificate information, with the majority responding 3-4 months postpartum. The survey is administered in both English and Spanish. Mothers of twins and triplets have one infant randomly selected by the state's Department of Public Health to be the index infant. Mothers whose pregnancy ended in stillbirth or multiple births greater than triplets are excluded. Data included information obtained from the infant's birth certificate and survey questions. Data for each site are weighted annually for sampling design, nonresponse, and noncoverage to produce data representative of the site's birth population for the year (Bauman, 2020). The standardized data collection methodology enables between-state comparisons and single-state or multistate analysis (Bauman, 2020). The present study was approved by the CDC PRAMS and the PRAMS grantees at Connecticut, Louisiana, Massachusetts, Missouri, and Wisconsin.

### Exposures

Phase 8 of the PRAMS survey assessed stressful events using a standard question that examined a mother's experience with 14 types of stressors in the 12 months before the birth of their infant. These life stressors were coded yes vs. no and included the following: (1) *A close family member was very sick and had to go into the hospital*, (2) *I got separated or divorced from my husband or partner*, (3) *I moved to a new address*, (4) *I was homeless or had to sleep outside, in a car, or in a shelter*, (5) *My husband or partner lost their job*, (6) *I lost my job even though I wanted to go on working*, (7) *My husband, partner, or I had a cut in work hours or pay*, (8) *I was apart from my husband or partner due to military deployment or extended work-related travel*, (9) *I argued with my husband or partner more than usual*, (10) *My husband or partner said they didn't want me to be pregnant*, (11) *I had problems paying the rent, mortgage, or other bills*, (12) *My husband, partner, or I went to jail*, (13) *Someone very close to me had a problem with drinking or drugs*, (14) *Someone very close to me died*. As was done by Ahluwalia and used in the PRAMS 2008 CDC report, we grouped 12 stressful events into four categories: Partner-related stress (2, 8, 9, 10), Trauma-related stress (4, 12, 13), Financial Stress (5, 6, 7, 11) and Emotional stress (1, 14) (Ahluwalia et al., 2001; Morgan et al., 2020; *Prevalence of Self-Reported Postpartum Depressive Symptoms*, 2008.; Stone et al., 2015). Like Morgan et al (2020), we excluded the "moved to new address" question (3) as this could be perceived as a positive experience or the negative consequence of financial loss (Morgan et al., 2020). In addition, we examined total stressful events by creating a variable representing the total number of stressors each respondent experienced. We grouped this variable as follows: 1-3 stressors, 4-6 stressors, and  $\geq 7$  stressors, with "no reported stressors" as our reference.

### Outcomes

The outcome variable of interest in this study was maternal morbidity. We assessed specific types of maternal morbidity including gestational diabetes mellitus (GDM), hypertensive disorders of pregnancy (HDP: high blood pressure that started during pregnancy, pre-eclampsia, or eclampsia), prenatal depression (PND), and postpartum depression symptoms (PPD). The PRAMS questionnaire assessed GDM, HDP, and PND using a core question which asked if respondents experienced these conditions during their most recent pregnancy. Responses were coded in binary form "yes vs. no." PRAMS screens for postpartum depression symptoms as a surrogate for postpartum depression, considering that PPD is often not formally diagnosed. This was done using

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women's responses to: "*I have felt down, depressed or hopeless*" and "*I have had little interest or pleasure in doing things I usually enjoyed.*" The possible responses were on a 5-item Likert scale: never (1), rarely (2), sometimes (3), often (4), always (5). Participants who responded with "Always" or "Often" to either question were coded as "Yes" for postpartum depressive symptoms while those who responded with "Never/Rarely/Sometimes" were the reference group. We considered women who had any maternal morbidity as those who answered "Yes" to experiencing GDM, HDP, PND or PPD.

#### Covariates

We identified possible confounding variables using a directed acyclic graph (DAG)(Morgan et al., 2020); a visual tool which displays assumptions about the relationship between variables, informed by the literature on psychosocial stressors and maternal morbidity. Maternal age, maternal education, marital status, race/ethnicity, and pregnancy history (including plurality and parity) were captured from birth certificates while household income, prenatal health insurance, pregnancy intention, pre-pregnancy BMI, smoking during pregnancy, alcohol use during pregnancy, partner abuse (before and during pregnancy), preconception morbidity, and infertility treatment were obtained from the PRAMS questionnaire.

#### Data Analysis

Phase 8 (2016-2018) of the PRAMS questionnaire was completed by 24,209 mothers who were residents of Connecticut, Louisiana, Massachusetts, Missouri, and Wisconsin. We did not exclude respondents with missing data but accounted for this by re-coding missing values appropriately. Descriptive statistics of study participants were obtained by partner-related, traumatic, financial, and emotional stress (yes/no) and compared by chi-square tests to examine if any differences were significant. Likewise, we obtained descriptive statistics for types of life stressors by any maternal morbidity, GDM, HDP, PND, and PPD. We also examined the prevalence of life stressors and maternal morbidity by state and performed chi-square tests.

To evaluate the association between life stressors and maternal morbidity, we used modified Poisson regression models with robust error variance to estimate prevalence ratios (PR) and 95% confidence intervals (CI). We used a hybrid approach to determine confounders to include in regression models, including a DAG and *a priori* change in estimate criterion of >10%. Potential confounders were excluded from models if after their inclusion did not change PR estimate by more than 10%. However, we chose to retain maternal age, race/ethnicity, and BMI in all models to allow comparison with previous research(American College of Obstetricians and Gynecologists and the Society for Maternal–Fetal Medicine et al., 2016). Based on these criteria, all adjusted models controlled for maternal age, race/ethnicity, and BMI. We also included preconception morbidity (having depression, diabetes, or high blood pressure); marital status; education; partner abuse 12 months before pregnancy; partner abuse during pregnancy; pregnancy intention; income; smoking during pregnancy; and prenatal depression in specific models depending on if they fulfilled the change in estimate criterion of >10%.

All statistical analyses were performed using StataCorp, LLC Version 17.0. The analysis accounted for the complex survey design of PRAMS and included final survey weights to produce population-based estimates. Statistical significance was determined *a priori* at  $p < 0.05$  and non-overlapping 95% confidence intervals (CI).

## **RESULTS**

### Demographics of Study Population

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Of the 24,209 study participants, 60% were 25-34 years old, 60% were married, 37.7% had completed college, 34.2% had a household income of \$0 to \$24,000, 51.2% had private health insurance, 46.8% had Medicaid, and 1.99% were uninsured (Table 1). Sixty-four percent (64.2%) of the population identified as non-Hispanic White, 17.1% non-Hispanic Black, 12.9% Hispanic, 3.90% Asian, 1.06% American Indian/Alaskan Native, and the rest (0.79%) identified as other mixed races (Table 1). Among the respondents, we found that 3.25% experienced partner abuse before pregnancy, 2.23% experienced partner abuse during pregnancy, 8.99% smoked during pregnancy, 61.8% used alcohol 3 months before pregnancy, 25.7% were overweight, and 26.6% were obese. In addition, 77.6% of the study population intended to get pregnant, 38.7% were first time mothers, 19.0% had preconception morbidity, and 2.56% utilized infertility treatment. The prevalence of maternal characteristics differed significantly ( $p < 0.0001$ ) across states for all variables, except plurality (Table 1).

**Table 1:** Prevalence of Maternal Characteristics by State, Pregnancy Risk Assessment Monitoring System (PRAMS), 5 sites \*\*, 2016-2018 (N = 24,209)

Maternal Characteristics	Total (%)	CT (%)	LA (%)	MA (%)	MO (%)	WI (%)
<b>Maternal Age (in years)<sup>1</sup></b>						
≤ 19	4.03	2.93	6.28	1.84	5.34	3.43
20-24	18.1	12.1	26.1	11.0	21.9	17.3
25-34	60.0	60.6	54.5	60.3	60.0	64.5
≥ 35	17.9	24.4	13.1	26.9	12.7	14.8
<b>Maternal Education<sup>1</sup></b>						
< High school diploma	11.1	10.1	15.0	8.47	11.3	10.4
High school diploma	24.1	17.8	32.7	15.7	26.7	25.6
Some College	27.1	26.0	28.4	23.5	30.1	27.0
Completed college	37.7	46.2	23.8	52.4	31.9	37.0
<b>Marital Status<sup>1</sup></b>						
Married	60.0	63.2	45.5	67.3	60.8	63.1
Other	40.0	36.8	54.5	32.7	39.2	36.9
<b>Race/Ethnicity<sup>1</sup></b>						
Black	17.1	12.4	37.2	10.4	14.4	10.6
White	64.2	54.4	51.5	60.3	75.8	72.7
Hispanic	12.9	25.9	8.81	20.6	5.68	9.89
American Indian/Alaskan Native	1.06	0.39	0.56	0.66	1.56	1.78
Asian	3.90	5.70	1.22	7.03	1.88	4.48
Other	0.79	1.14	0.64	1.04	0.67	0.61
<b>Household Income<sup>1</sup></b>						
\$0 - \$24,000	34.2	21.7	53.2	24.8	36.3	27.2
\$24,001 - \$48,000	19.1	39.3	14.1	14.9	21.8	20.6
\$48,001 - \$73,000	14.2	26.1	11.0	10.9	15.3	16.7
>\$73,000	32.6	12.9	21.7	49.4	26.5	35.5
<b>Prenatal Health Insurance<sup>1</sup></b>						
Private	51.2	56.7	35.6	61.0	49.5	54.3
Medicaid	46.8	40.4	63.8	38.6	47.3	42.6
None	1.99	2.93	0.65	0.48	3.15	3.13
<b>Partner Abuse, before pregnancy<sup>1</sup></b>						
Yes	3.25	2.11	3.26	2.16	4.71	3.44
No	96.7	97.9	96.7	97.8	95.3	96.6
<b>Partner Abuse, during pregnancy<sup>1</sup></b>						
Yes	2.23	1.55	2.71	1.32	3.14	2.10
No	97.8	98.5	97.3	98.7	96.9	97.9
<b>Pregnancy Intention<sup>1</sup></b>						
Intended	77.6	80.9	73.4	81.9	73.7	79.5
Unintended	6.73	4.62	9.24	4.68	8.50	5.76
Unsure	15.7	14.4	17.3	13.5	17.8	14.7
<b>Pre-pregnancy BMI<sup>1</sup></b>						
Underweight (< 18.5)	2.98	3.07	3.69	2.57	3.63	2.01



Normal (18.5 – 24.9)	44.8	44.2	41.4	50.0	42.2	45.6
Overweight (25.0 – 29.9)	25.7	27.0	24.8	27.2	24.8	25.1
Obese (30.0+)	26.5	25.7	30.1	20.2	29.4	27.4
<b>Smoking, during pregnancy<sup>1</sup></b>						
Yes	8.89	5.09	9.44	4.70	13.3	10.1
No	91.1	94.9	90.6	95.3	86.7	89.9
<b>Alcohol Use, before pregnancy<sup>1</sup></b>						
Yes	61.8	60.4	53.7	64.4	60.4	69.1
No	38.2	39.6	46.3	35.6	39.6	30.9
<b>Preconception Morbidity<sup>1</sup></b>						
Yes	19.0	14.0	18.4	16.5	22.2	21.2
No	81.0	86.0	81.6	83.5	77.8	78.8
<b>Parity<sup>1</sup></b>						
None	38.7	42.7	36.6	43.2	35.9	36.7
One	33.7	33.8	32.4	36.6	33.2	32.4
Two or more	27.6	23.5	31.0	20.3	30.9	31.0
<b>Plurality<sup>2</sup></b>						
Single	98.1	98.3	98.2	98.1	97.9	98.2
Twin	1.84	1.65	1.74	1.81	2.08	1.79
Other Multiple	0.04	0.01	0.01	0.04	0.06	0.05
<b>Infertility Treatment<sup>1</sup></b>						
Yes	2.56	3.69	0.73	5.54	1.35	1.79
No	97.4	96.3	99.3	94.5	98.6	98.2

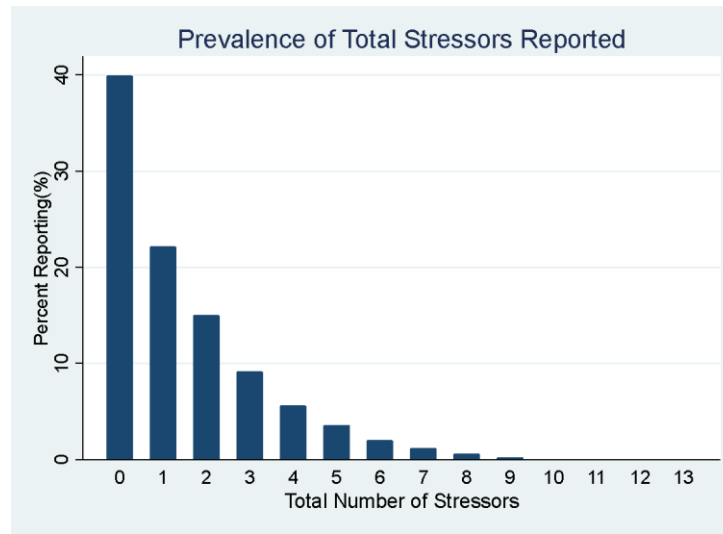
<sup>1</sup>Connecticut, Louisiana, Massachusetts, Missouri, and Wisconsin

<sup>2</sup>p<0.0001; <sup>3</sup>p>0.05; <sup>4</sup>Includes pre-pregnancy diabetes, depression, and hypertension

### Prevalence of Maternal Characteristics by Life Stressors

Nearly sixty percent (59.8%) of the women who answered the PRAMS question on major life events experienced at least one of the 13 types of stressors while 40.2% reported an absence of stressors 12 months before their new infant was born (Figure 1). Among women who experienced stressful events 12 months before the birth of their infant, the prevalence of grouped stressors ranged from 14.5% (traumatic stressors) to 31.2% (emotional stressors). We observed an association between each type of stressor and selected covariates (Table 2). Mothers who reported partner-related stress were more likely to be younger, unmarried, obese, Medicaid insured, have less than college education and lower household income than mothers who did not report these stressors. These women were also more likely to have reported a pregnancy intention of “unintended” or “unsure,” reported smoking during pregnancy, experienced partner abuse before or during their pregnancy, and had preconception morbidity compared to women who did not report partner-related stressors. A similar pattern was observed for women who experienced trauma-related, financial, and emotional stressors (Table 2). In addition, the results indicate racial disparities across types of stressors. Black Non-Hispanic women were more likely to report all types of stressors (Table 2). Likewise, Hispanic mothers had increased prevalence of partner-related and financial stressors. We also noted that women who identified as White Non-Hispanic were less likely to report partner-related and financial stressors (Table 2).

**Figure 1:** Prevalence of Total Stressors Reported in Connecticut, Louisiana, Massachusetts, Missouri, and Wisconsin —Pregnancy Risk Assessment Monitoring System (PRAMS), 2016-2018 (N = 24,209)



**Table 2:** Maternal Characteristics by Types of Stressors, Pregnancy Risk Assessment Monitoring System (PRAMS), 5 sites \*\*2016-2018 (N = 24,209)

Maternal Characteristics	Partner Stress (n = 23,832)		Trauma Stress (n = 23,819)		Financial Stress (n = 23,819)		Emotional Stress (n = 23,833)	
	Yes (27.8%)	No (72.2%)	Yes (14.5%)	No (85.5%)	Yes (31.0%)	No (69.0%)	Yes (31.2%)	No (68.8%)
<b>Maternal Age (in years)<sup>a</sup></b>								
≤ 19	6.05	3.21	6.47	3.58	4.91	3.58	4.81	3.64
20-24	25.6	15.0	26.8	16.5	24.4	15.1	19.4	17.3
25-34	53.3	62.8	54.1	61.2	56.4	61.8	59.5	60.4
≥ 35	15.0	19.0	12.6	18.8	14.3	19.5	16.4	18.6
<b>Maternal Education<sup>a</sup></b>								
< High school diploma	13.3	10.0	16.0	10.1	13.6	9.75	11.3	10.8
High school diploma	31.2	21.2	33.8	22.4	32.6	20.2	25.5	23.4
Some College	31.4	25.5	33.6	26.1	33.5	24.3	30.2	25.8
Completed college	24.0	43.2	16.6	41.4	20.3	45.7	33.0	40.1
<b>Marital Status<sup>a</sup></b>								
Married	41.0	67.5	34.9	64.4	42.2	68.2	56.2	61.9
Other	59.0	32.5	65.1	35.6	57.8	31.8	43.8	38.1
<b>Race/Ethnicity<sup>a</sup></b>								
Black	25.2	13.8	20.1	16.5	23.9	13.8	18.4	16.4
White	57.2	67.2	65.7	64.2	55.9	68.3	66.9	63.2
Hispanic	13.1	12.8	10.9	13.2	15.5	11.7	10.4	14.0
American Indian/Alaskan Native	1.47	0.91	2.15	0.88	1.65	0.80	1.65	0.80
Asian	2.46	4.42	1.01	4.36	2.31	4.58	2.16	4.66
Other	0.61	0.84	0.22	0.87	0.63	0.83	0.51	0.89
<b>Household Income<sup>a</sup></b>								
\$0 - \$24,000	49.9	27.9	55.8	30.3	53.2	25.4	37.9	32.4
\$24,001 - \$48,000	20.1	18.6	19.5	18.9	22.1	17.6	19.3	18.9
\$48,001 - \$73,000	11.1	15.4	10.1	14.9	11.4	15.5	14.5	14.1
>\$73,000	18.9	38.1	14.6	35.8	13.2	41.6	28.3	34.6
<b>Prenatal Health Insuranc<sup>a</sup></b>								
Private	33.2	58.4	29.3	55.2	28.8	61.7	47.9	53.1
Medicaid	65.6	39.3	69.7	42.6	69.7	36.1	50.5	44.8

None	1.18	2.31	0.97	2.17	1.43	2.25	1.62	2.17
<b>Partner Abuse, before pregnancy<sup>a</sup></b>								
Yes	9.97	0.83	13.5	1.53	7.63	1.30	4.88	2.53
No	90.4	99.2	86.5	98.5	92.4	98.7	95.1	97.5
<b>Partner Abuse, during pregnancy<sup>a</sup></b>								
Yes	6.97	0.41	9.68	0.98	5.41	0.81	3.72	1.56
No	93.0	99.6	90.3	99.0	94.6	99.2	96.3	98.4
<b>Pregnancy Intention<sup>a</sup></b>								
Intended	67.0	81.9	63.6	80.1	68.3	82.0	75.3	78.9
Unintended	11.5	4.89	12.2	5.79	10.6	4.96	7.84	6.22
Unsure	21.5	13.2	24.2	14.1	21.1	13.0	16.8	14.9
<b>Pre-pregnancy BMI<sup>a</sup></b>								
Underweight (< 18.5)	3.53	2.74	3.69	2.84	3.21	2.86	2.75	3.07
Normal (18.5 – 24.9)	39.8	46.7	39.7	45.6	38.4	47.6	40.8	46.5
Overweight (25.0 – 29.9)	25.1	25.9	24.4	25.9	24.8	26.1	26.0	25.6
Obese (30.0+)	31.6	24.7	32.3	25.6	33.6	23.5	30.4	24.8
<b>Smoking, during pregnancy<sup>a</sup></b>								
Yes	15.7	6.22	24.9	6.14	15.6	5.82	12.7	7.15
No	84.3	93.8	75.1	93.9	84.4	94.2	87.3	92.9
<b>Alcohol Use, before pregnancy</b>								
Yes	62.0	61.8	65.1 <sup>b</sup>	61.3	59.0 <sup>a</sup>	63.2	65.9 <sup>a</sup>	60.0
No	38.0	38.2	34.9	38.7	41.0	36.8	34.1	40.0
<b>Preconception Morbidity<sup>a,d</sup></b>								
Yes	30.4	14.5	37.7	15.8	29.4	14.3	24.8	16.3
No	69.6	85.5	62.3	84.2	70.6	85.7	75.2	83.7
<b>Parity</b>								
None	36.3 <sup>a</sup>	39.6	36.7 <sup>a</sup>	39.0	36.1 <sup>a</sup>	39.9	38.6	38.7
One	32.2 <sup>a</sup>	34.3	31.5 <sup>a</sup>	34.1	32.0 <sup>a</sup>	34.5	32.7	34.2
Two or more	31.5 <sup>a</sup>	26.1	31.8 <sup>a</sup>	26.9	31.9 <sup>a</sup>	25.6	28.7	27.1
<b>Plurality</b>								
Single	98.4	98.0	98.5	98.0	98.2	98.1	98.2	98.1
Twin	1.60	1.93	1.45	1.91	1.84	1.84	1.82	1.86
Other Multiple	0.01	0.05	0.00	0.05	0.01	0.06	0.01	0.05
<b>Infertility Treatment</b>								
Yes	1.48 <sup>a</sup>	2.98	1.33 <sup>a</sup>	2.78	1.11 <sup>a</sup>	3.22	2.49 <sup>a</sup>	2.60
No	98.5 <sup>a</sup>	97.0	98.7 <sup>a</sup>	97.2	98.9 <sup>a</sup>	96.8	97.5 <sup>a</sup>	97.4

<sup>a</sup>Connecticut, Louisiana, Massachusetts, Missouri, and Wisconsin

<sup>b</sup>p<0.001; <sup>c</sup>p<0.01; <sup>d</sup>p<0.05; <sup>d</sup> Includes pre-pregnancy diabetes, depression, and hypertension

Note: Total 'N' differs due to different missing values for each variable

### Prevalence of Life Stressors by Maternal Morbidity (GDM, HDP, PND & PPD)

The prevalence of individual stressor types ranged from 2.80% for “homeless” to 24.0% for “family member ill” (Table 3). Of the women who answered questions on pregnancy complications, 36.0% reported experiencing some form of maternal morbidity. Experiencing any maternal morbidity was strongly associated with partner (38.0% versus 22.0%;  $p < 0.001$ ), trauma (20.9% versus 10.9%;  $p < 0.001$ ), financial (40.5% versus 25.7%;  $p < 0.001$ ), and emotional stress (36.4% versus 28.3%;  $p < 0.001$ ). However, we did not observe any significant difference in the prevalence of stressors for partner-related stress due to being “apart from partner, work related.”

Gestational diabetes mellitus (GDM) was experienced by 8.9% of the population. Among participants who experienced GDM, 11.2% reported financial stress due to experiencing job loss compared to 9.50% who did not experience GDM ( $p = 0.03$ ). In addition, 13.5% of the population experienced hypertensive disorders of pregnancy (HDP). HDP was strongly linked with individual and grouped financial and emotional stressors (Table 3). In addition, we also observed a strong association for HDP and grouped partner-related and traumatic stressors. Overall, women who did versus did not have HDP were more likely to report traumatic stress due to being homeless (4.37% versus 2.50%;  $p < 0.001$ ) or having someone close who had alcohol/drug problems (13.3% versus

11.1%;  $p < 0.01$ ). An even stronger association was indicated in the analysis of individual partner-related stressors. Among women who reported HDP, 8.19% versus 6.73% ( $p < 0.01$ ) experienced stress due to separation/divorce, 26.1% versus 19.5% ( $p < 0.001$ ) argued with their partner more than usual, and 7.95% versus 5.54% ( $p < 0.001$ ) reported stress due to partner who did not want pregnancy.

**Table 3:** Prevalence of Life Stressors by Maternal Morbidity—Pregnancy Risk Assessment Monitoring System (PRAMS), 5 sites \*\*, 2016-2018 (N = 24,209)

	Total (%)	Any Maternal Morbidity <sup>1</sup>			GDM <sup>2</sup>			HDP <sup>3</sup>		
		Yes 36.0%	No 64.0%	p-value*	Yes 8.97%	No 91.0%	p-value*	Yes 13.5%	No 86.5%	p-value*
<b>Partner-Related</b>	27.8	38.3	22.0	<0.001	26.9	27.9	0.45	34.0	26.8	<0.001
Separation/Divorce	6.93	9.90	5.27	<0.001	7.45	6.86	0.42	8.19	6.73	0.01
Apart from partner, work related	4.08	4.31	3.95	0.30	3.74	4.12	0.54	4.51	4.03	0.32
Argued w/ partner more than usual	20.4	30.1	15.1	<0.001	19.3	20.5	0.28	26.1	19.5	<0.001
Partner did not want pregnancy	5.89	9.50	3.87	<0.001	6.70	5.79	0.19	7.95	5.54	<0.001
<b>Trauma-Related</b>	14.5	20.9	10.9	<0.001	16.0	14.3	0.12	17.7	13.9	<0.001
Homeless	2.80	4.78	1.68	<0.001	3.56	2.70	0.07	4.37	2.50	<0.001
Mother or partner went to jail	3.35	5.46	2.18	<0.001	4.42	3.26	0.05	3.84	3.29	0.24
Someone close had alcohol/drug problem	11.4	16.3	8.66	<0.001	12.4	11.3	0.25	13.3	11.1	<0.01
<b>Financial</b>	31.0	40.5	25.7	<0.001	32.2	30.8	0.32	38.1	29.9	<0.001
Partner lost job	9.64	13.7	7.39	<0.001	9.99	9.56	0.62	12.2	9.22	<0.001
Mother lost job	9.71	13.4	7.62	<0.001	11.2	9.50	0.03	11.7	9.38	<0.001
Family member hours/pay reduced	17.0	21.6	14.4	<0.001	18.2	16.9	0.22	20.7	16.4	<0.001
Could not pay bills	17.1	25.0	12.7	<0.001	17.1	17.1	0.99	22.5	16.3	<0.001
<b>Emotional</b>	31.2	36.4	28.3	<0.001	32.1	31.1	0.43	36.3	30.4	<0.001
Family member was ill	24.0	28.2	21.7	<0.001	25.3	23.8	0.24	28.4	23.3	<0.001
Someone close died	17.8	21.8	15.6	<0.001	18.2	17.8	0.67	21.3	17.2	<0.001

\*Italicized p-values are significant at  $p < 0.05$

\*\*Connecticut, Louisiana, Massachusetts, Missouri, and Wisconsin

<sup>1</sup>Any Maternal Morbidity: Includes Gestational Diabetes Mellitus, Hypertensive Disorders of Pregnancy, Prenatal Depression, and Postpartum Depression Symptoms

<sup>2</sup>GDM: Gestational Diabetes Mellitus

<sup>3</sup>HDP: Hypertensive Disorders of Pregnancy (includes pregnancy induced hypertension or eclampsia)

The prevalence of prenatal depression (PND) and postpartum depressive symptoms (PPD) was 14.2% and 12.7% respectively. The strongest link between life stressors and PND or PPD was in the area of individual and grouped trauma-related, financial, and emotional stressors (Table 4). Although we noted similarly strong associations between PND/PPD and partner related stressors, we did not find an appreciable difference between having PND/PPD and experiencing partner-related stress based on being apart from partner due to work.

**Table 4:** Prevalence of Life Stressors by Prenatal and Postpartum Depression, Pregnancy Risk Assessment Monitoring System (PRAMS), 5 sites \*\*, 2016-2018 (N = 24,209)

	Total (%)	Prenatal Depression			Postpartum Depressive Symptoms		
		Yes (14.2%)	No (85.8%)	p-value*	Yes (12.7%)	No (87.3%)	p-value*
<b>Partner-Related</b>	27.8	54.2	23.5	<0.001	48.4	24.8	<0.001
Separation/Divorce	6.93	15.1	5.61	<0.001	12.8	6.09	<0.001
Apart from partner, work related	4.08	4.26	4.07	0.69	4.26	4.07	0.71
Argued w/ partner more than usual	20.4	44.6	16.5	<0.001	39.5	17.6	<0.001
Partner did not want pregnancy	5.89	14.9	4.38	<0.001	12.5	4.93	<0.001
<b>Trauma-Related</b>	14.5	33.6	11.3	<0.001	26.4	12.7	<0.001
Homeless	2.80	8.64	1.82	<0.001	6.69	2.22	<0.001
Mother or partner went to jail	3.35	9.23	2.39	<0.001	7.54	2.74	<0.001
Someone close had alcohol/drug problem	11.4	26.3	8.98	<0.001	20.3	10.1	<0.001

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<b>Financial</b>	31.0	54.6	27.1	<0.001	48.3	28.4	<0.001
<i>Partner lost job</i>	9.64	20.0	7.90	<0.001	16.6	8.60	<0.001
<i>Mother lost job</i>	9.71	18.6	8.24	<0.001	17.1	8.60	<0.001
<i>Family member hours/pay reduced</i>	17.0	27.6	15.3	<0.001	24.7	15.8	<0.001
<i>Could not pay bills</i>	17.1	37.2	13.8	<0.001	33.4	14.7	<0.001
<b>Emotional</b>	31.2	44.6	29.0	<0.001	38.3	30.3	<0.001
<i>Family member was ill</i>	24.0	34.5	22.3	<0.001	28.8	23.4	<0.001
<i>Someone close died</i>	17.8	27.8	16.1	<0.001	24.0	16.9	<0.001

<sup>a</sup>Italicized p-values are significant at  $p < 0.05$

<sup>\*\*</sup>Connecticut, Louisiana, Massachusetts, Missouri, and Wisconsin

### Prevalence of Life Stressors and Maternal Morbidity by State

Overall, respondents from Louisiana were the most likely to report 1-3 stressors (48.6%) and 4-6 stressors (16.3%) while Missouri had the highest prevalence of  $\geq 7$  stressors (3.37%) (Table 5). Participants from Louisiana were the most likely to report partner-related stressors (37.9%) and financial stressors (39.7%). Missouri had the highest prevalence of trauma-related stressors (17.3%) and emotional stressors (35.5%). Likewise, Missouri had the highest prevalence of any maternal morbidity (39.1%). The prevalence of GDM ranged from 8.32% for Louisiana and Massachusetts to 10.9% for Connecticut, HDP prevalence ranged from 11.8% for Connecticut to 16.3% for Louisiana, PND prevalence ranged from 10.3% for Connecticut to 18.1% for Missouri, and PPD prevalence ranged from 10.5% for Massachusetts to 15.3% for Louisiana.

**Table 5:** Prevalence of Life Stressors and Maternal Morbidity by State—Pregnancy Risk Assessment Monitoring System (PRAMS), 5 sites<sup>a</sup>, 2016-2018 (N = 24,209)

	CT (%)	LA (%)	MA (%)	MO (%)	WI (%)
<b>Total Stressor<sup>b</sup></b>					
No Stressor	43.9	32.4	45.7	36.8	43.4
1-3 Stressors	46.3	48.6	45.2	47.0	44.9
4-6 Stressors	8.42	16.3	7.70	12.8	9.68
$\geq 7$ Stressors	1.36	2.75	1.39	3.37	2.06
<b>Type of Stressor<sup>b</sup></b>					
Partner-Related	22.9	37.9	22.1	29.9	24.7
Trauma-Related	11.4	14.6	12.5	17.3	14.9
Financial	27.8	39.7	26.1	32.3	28.2
Emotional	29.6	31.0	27.7	35.5	31.4
<b>Any Maternal Morbidity<sup>c</sup></b>	33.7	37.8	33.0	39.1	35.2
<b>GDM<sup>d</sup></b>	10.9	8.32	8.32	9.09	9.15
<b>HDP<sup>e</sup></b>	11.8	16.3	12.0	14.3	12.2
<b>PND<sup>f</sup></b>	10.3	12.9	12.1	18.1	15.5
<b>PPD<sup>g</sup></b>	11.4	15.3	10.5	14.0	11.7

<sup>1</sup> $p < 0.0001$ ; <sup>2</sup> $p = 0.02$

<sup>a</sup>Connecticut, Louisiana, Massachusetts, Missouri, and Wisconsin

<sup>b</sup>Any Maternal Morbidity: Includes Gestational Diabetes Mellitus, Hypertensive Disorders of Pregnancy, Prenatal Depression, and Postpartum Depression Symptoms

GDM: Gestational Diabetes Mellitus

HDP: Hypertensive Disorders of Pregnancy (includes pregnancy induced hypertension or preeclampsia)

PND: Prenatal Depression

PPD: Postpartum Depression Symptoms

### Prevalence of Maternal Characteristics by GDM, HDP, PND and PPD

Mothers who reported GDM were more likely to have the following characteristics:  $\geq 35$  years, Hispanic, Asian, less than high school diploma, pre-pregnancy BMI corresponding to obesity, preconception morbidity, and multiparous pregnancy (Table 6). The prevalence of HDP was higher among women who: did not have a college degree, were not married, identified as non-Hispanic Black or American Indian/Alaskan Natives, had a household income of \$0-24,000,

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utilized Medicaid, experienced partner abuse before pregnancy, did not intend to get pregnant when they conceived or were unsure of their pregnancy intentions (Table 6). HDP prevalence was also increased among those were obese, smoked during pregnancy, had preconception morbidity, were nulliparous or primiparous, had plurality of two or more, and utilized infertility treatment before conception (Table 6).

We observed the increased prevalence of PND and PPD among women who: were  $\leq 24$  years of age, had less than college degree, had multiparous pregnancy, were not married, utilized Medicaid, did not intend to get pregnant when they did or were unsure, experienced partner abuse before or during pregnancy, smoked during pregnancy, and had preconception morbidity (Table 6). Mothers who had PND were also more likely to be obese, have a household income of \$0-24,000, identify as Black Non-Hispanic, White Non-Hispanic or American Indian/Alaskan Natives (Table 6). PPD prevalence was also notably higher for women who identified as Black Non-Hispanic or Hispanic, had a household income  $\leq$  \$48,000, were underweight or obese (Table 6).

**Table 6:** Maternal Characteristics by Types of Maternal Morbidity, Pregnancy Risk Assessment Monitoring System (PRAMS), 5 sites \*\*, 2016-2018 (N = 24,209)

Maternal Characteristics	GDM		HDP		PND		PPD	
	Yes (8.97%)	No (91.0%)	Yes (13.5%)	No (86.5%)	Yes (14.2%)	No (85.8%)	Yes (12.7%)	No (87.3%)
<b>Maternal Age (in years)</b>								
≤ 19	1.69	4.23	4.55	3.93	6.19	3.64	6.57	3.60
20-24	10.8	18.7	18.9	17.9	25.4	16.8	25.6	16.9
25-34	61.7	60.0	57.8	60.4	55.0	60.9	53.2	61.1
≥ 35	25.8	17.1	18.7	17.8	13.5	18.6	14.6	18.4
<b>Maternal Education</b>								
< High school diploma	13.1	10.7	11.5	10.8	16.8	9.90	15.6	10.3
High school diploma	23.6	24.1	28.1	23.4	33.1	22.6	32.2	22.8
Some College	28.4	27.0	29.1	26.9	29.5	26.8	28.9	26.9
Completed college	34.9	38.2	31.3	38.9	20.6	40.7	23.4	40.0
<b>Marital Status</b>								
Married	62.5	60.0	52.2	61.4	40.7	63.4	44.7	62.6
Other	37.5	40.0	47.8	38.6	59.3	36.6	55.3	37.4
<b>Race/Ethnicity</b>								
Black	15.7	17.1	23.6	16.0	18.3	16.8	24.0	15.9
White	57.5	65.0	62.5	64.7	66.5	64.1	54.8	66.0
Hispanic	17.5	12.5	10.2	13.3	11.2	13.2	13.3	12.8
American Indian/Alaskan Native	1.19	1.02	1.22	1.03	2.06	0.88	1.84	0.94
Asian	7.40	3.54	2.10	4.15	1.57	4.26	5.03	3.70
Other	0.72	0.77	0.35	0.83	0.43	0.82	1.02	0.71
<b>Household Income</b>								
\$0 - \$24,000	33.1	34.1	41.2	32.9	53.0	30.8	52.3	31.5
\$24,001 - \$48,000	20.0	18.9	18.5	19.1	18.9	19.0	20.6	18.8
\$48,001 - \$73,000	16.3	14.0	13.0	14.4	10.7	14.8	9.40	14.8
>\$73,000	30.6	33.0	27.3	33.6	17.4	35.4	17.8	34.9
<b>Prenatal Health Insurance</b>								
Private	50.3	51.6	46.5	52.2	31.5	54.7	33.6	54.1
Medicaid	48.4	46.4	52.0	45.7	67.0	43.3	64.4	43.9
None	1.35	2.05	1.49	2.07	1.50	2.05	2.00	2.00
<b>Partner Abuse, before pregnancy</b>								
Yes	3.37	3.23	4.54	3.04	10.2	2.11	8.92	2.44
No	96.6	96.8	95.5	97.0	89.8	97.9	91.1	97.6
<b>Partner Abuse, during pregnancy</b>								
Yes	2.73	2.18	2.69	2.15	7.05	1.42	6.50	1.62
No	97.3	97.8	97.3	97.9	92.9	98.6	93.5	98.4
<b>Pregnancy Intention</b>								
Intended	76.2	77.9	73.5	78.4	63.8	80.0	64.7	79.7

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Untended Unsure	7.63 <i>16.1</i>	6.60 <i>15.5</i>	8.63 17.8	6.41 15.2	13.5 22.7	5.59 14.4	12.9 22.4	5.82 14.5
<b>Pre-pregnancy BMI</b>								
Underweight (< 18.5)	1.64	3.11	1.05	3.28	3.16	2.95	3.71	2.87
Normal (18.5 – 24.9)	29.5	46.3	30.9	47.0	38.0	46.0	39.4	45.6
Overweight (25.0 – 29.9)	25.1	25.7	26.5	25.5	23.2	26.1	23.4	25.9
Obese (30.0+)	43.8	24.8	41.5	24.2	35.7	25.0	33.4	25.6
<b>Smoking, during pregnancy</b>								
Yes	8.90	8.86	10.5	8.64	22.3	6.64	16.0	7.83
No	<i>91.1</i>	<i>91.1</i>	89.5	91.4	77.7	93.4	84.0	92.2
<b>Alcohol Use, before pregnancy</b>								
Yes	55.4	62.5	62.1	<i>61.9</i>	<i>62.1</i>	<i>61.8</i>	56.3	62.7
No	44.6	37.5	37.9	<i>38.1</i>	<i>37.9</i>	<i>38.2</i>	43.7	37.3
<b>Preconception Morbidity**</b>								
Yes	27.2	18.1	33.0	16.7	72.5	10.0	40.2	15.9
No	72.8	81.9	67.0	83.3	27.5	90.0	59.8	84.1
<b>Parity</b>								
None	32.0	39.4	46.3	37.6	35.1	39.4	36.9	39.0
One	33.8	33.8	27.8	34.7	31.3	34.2	31.9	34.0
Two or more	34.1	26.8	25.9	27.7	33.6	26.4	31.2	27.0
<b>Plurality</b>								
Single	97.9	98.1	96.5	98.4	98.5	98.0	97.7	98.2
Twin	2.08	1.82	3.35	1.60	1.49	1.90	2.33	1.74
Other Multiple	0.00	0.04	0.17	0.02	0.00	0.04	0.00	0.04
<b>Infertility Treatment</b>								
Yes	2.35	2.60	3.52	2.44	1.14	2.82	1.22	2.78
No	<i>97.7</i>	<i>97.4</i>	96.5	97.6	98.9	97.2	98.8	97.2

Connecticut, Louisiana, Massachusetts, Missouri, and Wisconsin

\*\*Includes pre-pregnancy diabetes, depression, and hypertension

Note: Italicized values indicate no significant difference at  $p > 0.05$

### Prevalence of Maternal Characteristics by Total Number of Stressors

Respondents who experienced  $\geq 7$  total stressors were more likely to: be younger ( $\leq 24$  years old), unmarried, have no college education, identify as non-Hispanic Black, have a household income of \$0-24,000, utilize Medicaid, experience partner abuse before or during pregnancy, did not intend to get pregnant when they did or were unsure (Table 7). Women who reported  $\geq 7$  total stressors had increased prevalence of being underweight or obese, smoking during pregnancy, alcohol use before pregnancy, preconception morbidity, and multiparous pregnancy (Table 7).

**Table 7:** Maternal Characteristics by Total Number of Stressors, Pregnancy Risk Assessment Monitoring System (PRAMS), 5 sites \*\*, 2016-2018 (N = 24,209)

Maternal Characteristics	No Stressor (%)	1-3 Stressors (%)	4-6 Stressors (%)	$\geq 7$ Stressors (%)
<b>Maternal Age (in years)<sup>1</sup></b>				
$\leq 19$	2.93	4.21	6.41	6.84
20-24	13.3	18.8	28.2	34.5
25-34	63.5	59.4	52.7	50.3
$\geq 35$	20.3	17.5	12.7	8.39
<b>Maternal Education<sup>1</sup></b>				
< High school diploma	9.91	10.3	15.8	20.1
High school diploma	18.4	25.5	34.8	40.3
Some College	22.0	29.2	36.4	32.4
Completed college	49.7	35.0	13.1	7.23
<b>Marital Status<sup>1</sup></b>				
Married	72.5	58.3	31.4	20.3
Other	27.5	41.7	68.6	79.7
<b>Race/Ethnicity<sup>1</sup></b>				
Black	12.4	17.9	26.9	29.3
White	67.9	63.7	56.4	57.1
Hispanic	12.2	13.7	12.5	10.3
American Indian/Alaskan Native	0.63	1.03	2.50	2.08

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Asian	5.79	3.02	1.35	0.55
Other	1.07	0.61	0.40	0.70
<b>Household Income<sup>1</sup></b>				
\$0 - \$24,000	22.8	34.4	64.5	71.4
\$24,001 - \$48,000	17.0	20.8	18.9	18.2
\$48,001 - \$73,000	15.1	15.3	8.52	5.54
>\$73,000	45.1	29.5	7.99	4.90
<b>Prenatal Health Insurance<sup>1</sup></b>				
Private	65.2	48.7	20.9	12.0
Medicaid	32.2	49.5	77.9	87.1
None	2.60	1.75	1.11	0.85
<b>Partner Abuse, before pregnancy<sup>1</sup></b>				
Yes	0.41	2.47	11.0	31.9
No	99.6	97.5	89.0	68.1
<b>Partner Abuse, during pregnancy<sup>1</sup></b>				
Yes	0.13	1.50	8.62	22.8
No	99.9	98.5	91.4	77.2
<b>Pregnancy Intention<sup>1</sup></b>				
Intended	84.4	77.1	61.8	51.9
Unintended	3.86	7.02	14.0	15.3
Unsure	11.7	15.9	24.1	32.7
<b>Pre-pregnancy BMI<sup>1</sup></b>				
Underweight (< 18.5)	2.98	2.72	3.48	5.10
Normal (18.5 – 24.9)	49.7	43.0	36.7	31.6
Overweight (25.0 – 29.9)	25.9	26.1	23.4	24.9
Obese (30.0+)	21.3	28.2	36.4	38.4
<b>Smoking, during pregnancy<sup>1</sup></b>				
Yes	3.80	8.75	21.6	37.7
No	96.2	91.2	78.4	62.3
<b>Alcohol Use, before pregnancy<sup>2</sup></b>				
Yes	60.5	63.2	61.0	64.1
No	39.5	36.8	39.0	35.9
<b>Preconception Morbidity<sup>1,4</sup></b>				
Yes	11.3	19.4	37.4	54.7
No	88.7	80.6	62.6	45.3
<b>Parity<sup>1</sup></b>				
None	40.2	38.4	36.0	32.1
One	35.0	33.8	30.0	29.0
Two or more	24.8	27.8	34.0	38.9
<b>Plurality<sup>3</sup></b>				
Single	97.9	98.2	98.8	97.6
Twin	2.02	1.82	1.19	2.35
Other Multiple	0.08	0.01	0.00	0.00
<b>Infertility Treatment<sup>1</sup></b>				
Yes	3.30	2.46	0.85	0.29
No	96.7	97.5	99.1	99.7

<sup>1</sup>Connecticut, Louisiana, Massachusetts, Missouri, and Wisconsin

<sup>2</sup>p<0.001; <sup>3</sup>p<0.01; <sup>4</sup>p<0.05; <sup>1</sup>Includes pre-pregnancy diabetes, depression, and hypertension

### Prevalence of Maternal Morbidity by Total Number of Stressors

Women who reported  $\geq 7$  total stressors had the highest prevalence of maternal morbidity (Table 8). Specifically, the prevalence of hypertensive disorders of pregnancy, prenatal depression and postpartum depression symptoms was higher among women who had  $\geq 7$  total stressors. However, we did not observe any significant difference in the prevalence of the total number of stressors among women who had gestational diabetes mellitus (Table 8).



**Table 8:** Maternal Morbidity by Total Number of Stressors, Pregnancy Risk Assessment Monitoring System (PRAMS), 5 sites\*\*, 2016-2018 (N = 24,209)

<i>Maternal Morbidity</i>	No Stressor (%)	1-3 Stressors (%)	4-6 Stressors (%)	≥ 7 Stressors (%)	p-value
<i>Any Maternal Morbidity</i>					<0.0001
Yes	28.0	36.2	55.7	71.9	
No	72.0	63.8	44.3	28.1	
<i>Gestational Diabetes Mellitus</i>					0.14
Yes	9.05	8.72	8.98	12.5	
No	91.0	91.3	91.0	87.5	
<i>Hypertensive Disorders of Pregnancy</i>					<0.0001
Yes	11.0	14.1	17.9	18.8	
No	89.0	85.9	82.1	81.2	
<i>Prenatal Depression</i>					<0.0001
Yes	6.24	14.0	34.9	53.4	
No	93.8	86.0	65.1	46.6	
<i>Postpartum Depression Symptoms</i>					<0.0001
Yes	7.93	12.1	26.6	36.5	
No	92.1	87.9	73.4	63.5	

\*Connecticut, Louisiana, Massachusetts, Missouri, and Wisconsin

Association between Life Stressors and Maternal Morbidity (GDM, HDP, PND, & PPD)

The unadjusted association between maternal morbidity and total number of stressors indicated a mild dose-response relationship. Compared to mothers who reported no stressors, mothers who reported 1-3 stressors, 4-6 stressors and ≥ 7 stressors had a 1.30 (95% CI: 1.23, 1.37), 1.99 (95% CI: 1.88, 2.12), and 2.57 (95% CI: 2.37, 2.79) higher prevalence ratio of maternal morbidity respectively (Table 9). After adjustment for preconception morbidity, BMI, race/ethnicity, age, marital status, education, income, and smoking during pregnancy, the observed dose-response effect diminished despite the increases in the prevalence ratio of maternal morbidity across each category of total stressors. Women who did versus did not report partner-related stressors had the highest increase in prevalence ratio of maternal morbidity (aPR = 1.31; 95% CI: 1.25, 1.37), after adjusting for preconception morbidity, BMI, race/ethnicity, and age.

Relative to women with no stressors, women who reported ≥ 7 stressors had a 1.38 (95% CI: 1.01, 1.89) higher prevalence ratio of having GDM (Table 9). These estimates were no longer significant after adjustment (aPR = 1.40; 95% CI: 1.00, 1.95). Similarly, unadjusted, and adjusted models did not show any significant increase in prevalence of GDM for women who reported partner-related, trauma-related, financial, and emotional stressors. Compared to mothers who reported no stressors, mothers who reported 1-3 stressors, 4-6 stressors and ≥ 7 stressors had a 1.29 (95% CI: 1.17, 1.42), 1.63 (95% CI: 1.43, 1.85), and 1.71 (95% CI: 1.34, 2.17) higher prevalence ratio of HDP respectively (Table 9). After adjustment for prior diagnosis of high blood pressure, BMI, race/ethnicity, age, marital status, and income, only estimates for women who reported 4-6 stressors versus those who did not report stressors remained significant (aPR = 1.18; 95% CI: 1.02, 1.37). We observed increased prevalence of HDP among women who reported and partner-related (PR = 1.34; 95% CI: 1.23, 1.46), trauma-related (PR = 1.27; 95% CI: 1.14, 1.42), financial (PR = 1.37; 95% CI: 1.25, 1.49), and emotional (PR = 1.26; 95% CI: 1.16, 1.37) stressors versus those who did not. However, after adjusting for prior diagnosis of high blood pressure, BMI, race/ethnicity, and age, estimates were null for women reported trauma-related stressors versus those who did not (aPR = 1.11; 95% CI: 1.00, 1.25).

The unadjusted analysis for PND and total number of stressors revealed a strong dose-response relationship. Women who reported 1-3 stressors, 4-6 stressors and ≥ 7 stressors had a

2.24 (95% CI: 1.99, 2.54), 5.59 (95% CI: 4.93, 6.35), and 8.56 (95% CI: 7.37, 9.34) higher prevalence ratio of PND respectively, compared to those who had no stressors (Table 9). Upon adjustment for depression before pregnancy, BMI, race/ethnicity, age, marital status, education, partner abuse 12 months before pregnancy, partner abuse during pregnancy, pregnancy intention, income, and smoking during pregnancy, we noted the highest increase in prevalence of PND among mothers who reported 4-6 stressors (aPR = 1.94; 95% CI: 1.69, 2.23). Likewise, we saw significant increases in the prevalence of PND for women who reported partner-related, trauma-related, financial, and emotional stressors (Table 9). The highest increase in prevalence of PND by type of stressor was among women who had partner-related stressors versus those who did not (PR = 3.07; 95% CI: 2.82, 3.34). This observation remained significant after adjusting for diagnosis of depression before pregnancy, BMI, race/ethnicity, age, marital status, education, income, and smoking during pregnancy (aPR = 1.58; 95% CI: 1.45, 1.72).

Our analysis of PPD and total number of stressors indicated a strong dose-response relationship (Table 9). Women who reported 1-3 stressors, 4-6 stressors and  $\geq 7$  stressors had a 1.53 (95% CI: 1.38, 1.70), 3.36 (95% CI: 2.98, 3.79), and 4.61 (95% CI: 3.88, 5.48) higher prevalence ratio of PPD respectively, compared to those who had no stressors. The dose response effect was attenuated upon adjustment for of depression before pregnancy, prenatal depression, BMI, race/ethnicity, age, marital status, education, partner abuse 12 months before pregnancy, partner abuse during pregnancy, pregnancy intention, income, and smoking during pregnancy, but the estimates remained significant. The analysis for type of stressors and PPD indicated significant increases in the prevalence of PPD for women who reported partner-related, trauma-related, financial, and emotional stressors (Table 9). Mothers who reported partner-related stressors had the highest increase in prevalence of PPD compared to those who did not report these stressors (PR = 2.44; 95% CI: 2.24, 2.65). The estimate remained significant after adjusting for diagnosis of depression before pregnancy, prenatal depression, BMI, race/ethnicity, age, marital status, and income (aPR = 1.63; 95% CI: 1.47, 1.80).

**Table 9:** Association between Life Stressors and Maternal Morbidity, Pregnancy Risk Assessment Monitoring System (PRAMS), 5 sites\*, 2016-2018 (N = 24,209)

Life Stressors	Any Maternal Morbidity <sup>1</sup> Yes vs. No (%)	Model 1 PR (95% CI)	Model 2 PR (95% CI)
<b>Total Stressor</b>			
1-3 Stressors	46.8 vs. 46.2	1.30 (1.23-1.37)	1.14 (1.08-1.21) <sup>a</sup>
4-6 Stressors	17.3 vs. 7.71	1.99 (1.88-2.12)	1.38 (1.28-1.48) <sup>a</sup>
$\geq 7$ Stressors	4.56 vs. 0.99	2.57 (2.37-2.79)	1.45 (1.32-1.59) <sup>a</sup>
<b>Type of Stressor</b>			
Partner-Related	38.3 vs. 22.0	1.61 (1.54-1.68)	1.31 (1.25-1.37) <sup>b</sup>
Trauma-Related	20.9 vs. 10.9	1.56 (1.48-1.64)	1.15 (1.10-1.22) <sup>c</sup>
Financial	40.5 vs. 25.7	1.51 (1.45-1.58)	1.20 (1.13-1.25) <sup>c</sup>
Emotional	36.4 vs. 28.3	1.26 (1.20-1.32)	1.12 (1.08-1.17) <sup>b</sup>
	<b>GDM<sup>2</sup></b> Yes vs. No (%)	<b>Model 1</b> PR (95% CI)	<b>Model 2<sup>a</sup></b> PR (95% CI)
<b>Total Stressor</b>			
1-3 Stressors	45.1 vs. 46.5	0.96 (0.86-1.08)	0.94 (0.84-1.06)
4-6 Stressors	11.2 vs. 11.2	0.99 (0.83-1.18)	0.99 (0.82-1.18)
$\geq 7$ Stressors	3.15 vs. 2.17	1.38 (1.01-1.89)	1.40 (1.00-1.95)
<b>Type of Stressor</b>			
Partner-Related	26.9 vs. 27.9	0.96 (0.85-1.07)	0.97 (0.86-1.09)
Trauma-Related	16.0 vs. 14.3	1.13 (0.97-1.31)	1.13 (0.97-1.32)
Financial	32.2 vs. 30.8	1.06 (0.95-1.18)	1.01 (0.90-1.14)
Emotional	32.1 vs. 31.1	1.05 (0.94-1.17)	1.05 (0.93-1.18)
	<b>HDP<sup>3</sup></b>	<b>Model 1</b>	<b>Model 2</b>

	Yes vs. No (%)	PR (95% CI)	PR (95% CI)
<b>Total Stressor</b>			
1-3 Stressors	48.9 vs. 45.9	1.29 (1.17-1.42)	1.08 (0.97-1.20) <sup>e</sup>
4-6 Stressors	15.0 vs. 10.6	1.63 (1.43-1.85)	1.18 (1.02-1.37) <sup>e</sup>
≥ 7 Stressors	3.18 vs. 2.13	1.71 (1.34-2.17)	1.14 (0.89-1.47) <sup>e</sup>
<b>Type of Stressor</b>			
Partner-Related	34.0 vs. 26.8	1.34 (1.23-1.46)	1.16 (1.06-1.27) <sup>f</sup>
Trauma-Related	17.7 vs. 13.9	1.27 (1.14-1.42)	1.11 (1.00-1.25) <sup>f</sup>
Financial	38.1 vs. 29.9	1.37 (1.25-1.49)	1.11 (1.01-1.23) <sup>g</sup>
Emotional	36.3 vs. 30.4	1.26 (1.16-1.37)	1.13 (1.04-1.24) <sup>f</sup>
	<b>PND<sup>4</sup></b>	<b>Model 1</b>	<b>Model 2</b>
	Yes vs. No (%)	PR (95% CI)	PR (95% CI)
<b>Total Stressor</b>			
1-3 Stressors	46.0 vs. 46.4	2.24 (1.99-2.54)	1.47 (1.31-1.66) <sup>h</sup>
4-6 Stressors	27.7 vs. 8.48	5.59 (4.93-6.35)	1.94 (1.69-2.23) <sup>h</sup>
≥ 7 Stressors	8.63 vs. 1.24	8.56 (7.37-9.34)	1.85 (1.56-2.19) <sup>h</sup>
<b>Type of Stressor</b>			
Partner-Related	54.2 vs. 23.5	3.07 (2.82-3.34)	1.58 (1.45-1.72) <sup>i</sup>
Trauma-Related	33.6 vs. 11.3	2.99 (2.75-3.25)	1.23 (1.13-1.34) <sup>j</sup>
Financial	54.6 vs. 27.1	2.68 (2.46-2.91)	1.35 (1.24-1.47) <sup>i</sup>
Emotional	44.6 vs. 29.0	1.77 (1.63-1.93)	1.22 (1.14-1.31) <sup>k</sup>
	<b>PPD<sup>5</sup></b>	<b>Model 1</b>	<b>Model 2</b>
	Yes vs. No (%)	PR (95% CI)	PR (95% CI)
<b>Total Stressor</b>			
1-3 Stressors	44.6 vs. 46.6	1.53 (1.38-1.70)	1.25 (1.10-1.42) <sup>l</sup>
4-6 Stressors	23.6 vs. 9.38	3.36 (2.98-3.79)	1.72 (1.47-2.00) <sup>l</sup>
≥ 7 Stressors	6.57 vs. 1.65	4.61 (3.88-5.48)	1.75 (1.41-2.17) <sup>l</sup>
<b>Type of Stressor</b>			
Partner-Related	48.4 vs. 24.8	2.44 (2.24-2.65)	1.63 (1.47-1.80) <sup>m</sup>
Trauma-Related	26.4 vs. 12.7	2.13 (1.93-2.34)	1.21 (1.08-1.36) <sup>n</sup>
Financial	48.3 vs. 28.4	2.09 (1.92-2.27)	1.38 (1.25-1.53) <sup>o</sup>
Emotional	38.3 vs. 30.3	1.36 (1.25-1.49)	1.12 (1.02-1.22) <sup>p</sup>

Note: Total 'N' differs due to different missing values for each variable

<sup>g</sup>Connecticut, Louisiana, Massachusetts, Missouri, and Wisconsin

<sup>1</sup>Any Maternal Morbidity: Includes Gestational Diabetes Mellitus, Hypertensive Disorders of Pregnancy, Prenatal Depression, and Postpartum Depression Symptoms

<sup>2</sup>GDM: Gestational Diabetes Mellitus

<sup>3</sup>HDP: Hypertensive Disorders of Pregnancy (includes pregnancy induced hypertension or preeclampsia)

<sup>4</sup>PND: Prenatal Depression

<sup>5</sup>PPD: Postpartum Depression Symptoms

Model 1: Unadjusted

Model 2: <sup>a</sup>Adjusted for preconception morbidity, BMI, race/ethnicity, age, marital status, education, income, smoking during pregnancy. <sup>b</sup>Adjusted for preconception morbidity, BMI, race/ethnicity, age. <sup>c</sup>Adjusted for preconception morbidity, BMI, race/ethnicity, age, income. <sup>d</sup>Adjusted for prior diagnosis of diabetes, BMI, race/ethnicity, age. <sup>e</sup>Adjusted for prior diagnosis of high blood pressure, BMI, race/ethnicity, age, marital status, income. <sup>f</sup>Adjusted for prior diagnosis of high blood pressure, BMI, race/ethnicity, age. <sup>g</sup>Adjusted for prior diagnosis of high blood pressure, BMI, race/ethnicity, age, income. <sup>h</sup>Adjusted for diagnosis of depression before pregnancy, BMI, race/ethnicity, age, marital status, education, partner abuse 12 months before pregnancy, partner abuse during pregnancy, pregnancy intention, income, smoking during pregnancy. <sup>i</sup>Adjusted for diagnosis of depression before pregnancy, BMI, race/ethnicity, age, marital status, education, partner abuse 12 months before pregnancy, pregnancy intention, income, smoking during pregnancy. <sup>j</sup>Adjusted for diagnosis of depression before pregnancy, BMI, race/ethnicity, age. <sup>k</sup>Adjusted for diagnosis of depression before pregnancy, prenatal depression, BMI, race/ethnicity, age, marital status, education, partner abuse 12 months before pregnancy, partner abuse during pregnancy, pregnancy intention, income, smoking during pregnancy. <sup>l</sup>Adjusted for diagnosis of depression before pregnancy, prenatal depression, BMI, race/ethnicity, age, marital status, education, partner abuse 12 months before pregnancy, pregnancy intention, income, smoking during pregnancy. <sup>m</sup>Adjusted for diagnosis of depression before pregnancy, prenatal depression, BMI, race/ethnicity, age, marital status, education, partner abuse 12 months before pregnancy, pregnancy intention, income, smoking during pregnancy. <sup>n</sup>Adjusted for diagnosis of depression before pregnancy, prenatal depression, BMI, race/ethnicity, age, marital status, education, partner abuse 12 months before pregnancy, pregnancy intention, income, smoking during pregnancy. <sup>o</sup>Adjusted for diagnosis of depression before pregnancy, prenatal depression, BMI, race/ethnicity, age, marital status, education, income. <sup>p</sup>Adjusted for diagnosis of depression before pregnancy, prenatal depression, BMI, race/ethnicity, age.

## DISCUSSION

In this study, we investigated the role of major stressful life events on maternal morbidity and examined differences in the impact of stressors on maternal morbidity by geography and race. Findings suggested that experiencing a greater number of stressors results in greater risk for maternal morbidity, confirming our first hypothesis. We also found that Black women were disproportionately impacted by stressors, thereby also experiencing heightened risk for maternal morbidity.

Over half of the women included in this study reported experiencing at least one life stressor. The most common stressors reported were emotional stressors, including a “*close family member who was very sick and had to go into the hospital*” and/or “*someone very close to me died,*” while the least common stress type reported was a traumatic life event. Women who reported partner-related, emotional, traumatic, and financial stressful events were more likely to report unintended pregnancy, low-income, a history of partner-related abuse, and preconception morbidities. Most notably, Black women reported increased rates of all four categories of stressors. Hispanic women were also more likely to report partner-related and financial stressors compared to non-Hispanic white women. Further, women who reported  $\geq 7$  stressors were more likely to be younger (<24 years old), Black, low-income women with no college education - identifying a particularly vulnerable group. Younger low-income women have been previously identified as higher risk to experience IPV (Napier et al., 2021). The prevalence of reported lifetime stress among Black women in an urban cohort was twice that of white women (Campbell et al., 2020). Additionally, studies have shown that high cumulative stress during pregnancy has more intense effects on the physiological stress response of Black women compared to white women (Simon et al., 2016). The increased effect of stress during pregnancy and the increased prevalence of life stressors could compound to further increase risk for adverse maternal outcomes among these vulnerable populations.

More than a third of the women surveyed reported experiencing any form of maternal morbidity. GDM and HDP was more common among women who identified as non-white. Women who experienced HDP during their pregnancies were more likely to be low-income, Black, and reported previous partner abuse prior to pregnancy. We found significant associations for all four categories of life stressors and experiencing an adverse outcome including HDP, PND, PPD. In previous studies, women who reported childhood trauma and adult stressors, including traumatic events, discrimination, and financial stressors, were at increased risk for prenatal depression (Evans et al., 2021). Women who reported moderate and high rates of stress during the prenatal and postpartum periods also reported greater maternal physical and mental health difficulties in the postpartum period (Racine et al., 2018). Various other studies have also confirmed the negative impact of stress on maternal and neonatal outcomes (Bush et al., 2021; Thiel et al., 2021). GDM was specifically associated with mothers reporting job loss, contributing to financial stress. Most notably, both GDM and HDP were associated with reporting increased rates of certain financial stressors, while experiencing HDP was additionally associated with traumatic stress and partner-related stress. Significant stressors in these areas included experiencing homelessness, being close with someone with alcohol or drug problems, divorce/separation with a partner, and stress with a partner who did not want a pregnancy. Perceived strong partner support has been tied to decreased distress postpartum and improved maternal and infant wellbeing (Battulga et al., 2021; Stapleton et al., 2012). Whereas IPV during pregnancy increases adverse maternal and neonatal outcomes (Alhusen et al., 2015; L. Zhang et al., 2021). Partner-related stress had the most significant increase in prevalence ratios for participants who reported any maternal morbidity, compared to other stress types included in this study. Prenatal and postpartum depression was especially associated with increased stress due to partner-related life stressors. Postpartum depression was additionally associated with experiencing trauma-related, financial, and emotional stressors after adjusting for confounders.

Our results additionally highlight geographical disparities in the number of stressors, types of stressors, and maternal morbidity experienced by participants. Louisiana and Missouri are

among states with the highest maternal mortality rate in the U.S; these geographical differences can be attributed to significant variations in the quality of state maternal mortality data and implementation of maternal health policies (*Explore Maternal Mortality*, 2019; *Severe Maternal Morbidity*, 2021). A factor that may contribute to these differences is access to healthcare and insurance coverage. Missouri has only recently expanded Medicaid, and in Louisiana, roughly 1 in every 6 children was delivered to a woman who had insufficient prenatal care in 2019 (Foubister, n.d.). Furthermore, in line with previous studies, our findings from Louisiana respondents suggest that experiencing partner-related and financial stressors during pregnancy may contribute to development of PPD symptoms (Qobadi et al., 2016). Louisiana participants also had the highest rates of HDP which significantly predicts SMM and maternal death (Malhamé et al., 2021). This could explain why in 2019 Louisiana had the highest maternal mortality rate in the country (Tatano Beck et al., 2011). In contrast, Missouri respondents had the highest prevalence of trauma-related stressors, emotional stressors, and PND (*Explore Maternal Mortality*, 2019). These findings are similar to studies which show that exposure to traumatic events during pregnancy could result in dysregulation of the hypothalamic pituitary adrenal (HPA) axis thereby increasing risk of prenatal depression (MGH Center for Women's Mental Health, 2013).

### Significance of Study Results

These results extend previous literature that identifies psychosocial stress as a contributor to maternal outcomes (Morgan et al., 2020; Neggers et al., 2006; Racine et al., 2018). Although several studies have highlighted the impact of racial discrimination on Black maternal health outcomes, fewer have examined racial disparities across major stressful life events (Alhusen et al., 2016; Wang et al., 2020). Additionally, previous studies that have examined major stressful life events using PRAMS were limited to single states or the impact of psychosocial stress specifically on preterm birth (Farr et al., 2014; Lu & Chen, 2004; Smith et al., 2015; Stone et al., 2015). These studies found that the prevalence of emotional, financial, partner-related, and traumatic stressors varies by women's anxiety and/or depressive symptoms (Farr et al., 2014). The prevalence of PPD (12.7%) in the present study is consistent with nationally reported prevalence estimates of PPD in the U.S which shows that PPD occurs in 10% to 15% of mothers (Tatano Beck et al., 2011). Our findings also echo results from Stone et al. (2015) which indicate a dose-response relationship with the prevalence ratio of PPD increasing as the number of stressors reported increased (Stone et al., 2015). The present finding of a dose-response relationship between types of stressors and PND strengthens results from previous studies which reveal that prenatal depression is positively associated with perceived (L. Zhang et al., 2020).

In agreement with Wilson et al. (2015), we did not find cumulative grouped stressors to be predictive of GDM. However, this finding differs from studies which suggest high perceived stress during pregnancy could be predictive of GDM (Mishra et al., 2020). While the current study found the strongest association between life stressors and maternal morbidity (specifically HDP, PND, and PPD) in the area of partner-related stress, previous studies show mixed results. One study found the strongest link for life stressors and HDP in the area of financial stress and did not observe significant estimates for women who experienced partner-related, emotional, or traumatic stress (Morgan et al., 2020). Yet, in line with our findings, another study found the strongest association between life stressors and PPD among those who reported partner-related stress (Stone et al., 2015).

The impact of stressful life events, resulting in psychosocial stress, have a clear impact on both maternal and neonatal outcomes. Our findings that these stressful life events are most

prevalent among Black low-income women demonstrate a possible mediator in the increased risk of maternal morbidities among Black women. Current interventions that have been shown to reduce stress during pregnancy are limited and often yield inconsistent results. These interventions include mindfulness-based interventions, cognitive behavioral therapy, relaxation techniques, yoga, and music-based interventions (Bright et al., 2020; Dhillon et al., 2017; Guo et al., 2021; Missler et al., 2021). Interventions, including screening-based, need to be developed and assessed to provide necessary support in populations at greater risk for social stressors and stressful life events. These vulnerable populations include women who are low-income, Black, and have a history of partner abuse prior to pregnancy.

These results demonstrate variance across states in the prevalence of types of life stressors among their pregnant population and adverse maternal health outcomes. These variances must be addressed and targeted. Maternal health policy both at the local and national level need to be informed by the needs in each state, especially in those with the highest maternal mortality rates. Over the last decade there has been a significant increase in the number of policies proposed addressing the Black maternal health crisis, though very few have been implemented (Carvalho et al., 2021). For example, expanding Medicaid coverage to include doulas could provide low-income women with emotional and social support to reduce stress and improve maternal outcomes (Kozhimannil et al., 2016)

#### Strengths & Limitations

Our study utilized data from a population-based survey which captures those at-risk for maternal morbidity and was weighted to be representative of all mothers who gave birth in Connecticut, Louisiana, Massachusetts, Missouri, and Wisconsin between 2016-2018. These states had >55% response rate to the PRAMS survey in 2018. In addition, this study adds to the growing literature on the impact of psychosocial stressors on the development of maternal morbidity. Our analysis of specific types of stressors enabled our elucidation of which common life stressors during pregnancy are associated with adverse maternal outcomes.

Yet, there were several limitations to our analysis. The population only represents those who had a recent live birth in the five PRAMS sites included. Like most cross-sectional studies, the findings in this study are subject to recall and misclassification bias as participants were surveyed 2-6 months postpartum and may overestimate/underestimate their experiences. In addition, due to the nature of the PRAMS questions, we were also unable to measure the duration, severity, and frequency of each stressor and as a result could not assess the stress level of each stressor. Also, we were not able to assess the impact of racial discrimination on psychosocial stress, as questions pertaining to this topic were not asked across states included in our analysis during Phase 8 of PRAMS. Our study included five states due to our focus on including major life events which were also not standardized questions on PRAMS Phase 8. Several states chose to add on questions pertaining to the topic, but our results do not encompass the national impact nor specific discrimination based psychosocial stress.

In separating the major life events into categories, we were not able to assess the interplay of the life stressors. We acknowledge that one cannot isolate life stressors and that there is need for further research on how these life stressors connect across categories. Lastly, in assessing maternal mortality and morbidity disparities that guided our research, the impact of homicide and IPV was not considered as these causes are pregnancy-associated rather than pregnancy-related causes of death. Our results demonstrate a need to examine disparities and trends related to partner-related stress, including IPV and maternal health outcomes in the future. Homicide is the most

common cause of death of pregnant women (Wallace et al., 2021). In fact, rates of homicide are 16% higher among pregnant women compared to their non-pregnant counterparts, most occurring in their homes and intimate-partner homicide rates are three times higher among Black females compared to white (Wallace et al., 2021). Pregnancy and postpartum serve as extremely high-risk time points for partner-related stress, IPV, and homicide demonstrating a need for more available interventions and resources addressing these issues.

### CONCLUSION

In this time of increased rates of psychosocial stress, postpartum anxiety, and depression symptoms due to the COVID-19 pandemic, the results of this analysis confirm the need to standardize screening for psychosocial stressors in prenatal care (Carvalho et al., 2021; Lewkowitz et al., 2021). Pregnancy is a period in the life course where one is exposed to a great amount of medical care, especially for low-income women who would not qualify for Medicaid insurance outside the pregnancy (Daw et al., 2017). In fact, pregnancy often acts as a period of time where women interact with the healthcare system when they otherwise do not or cannot (Daw et al., 2017). Universal screening programs to prevent postpartum distress have efficacy in decreasing symptoms of depression, anxiety, and stress (Missler et al., 2021). Psychosocial screening tools should be applied at regular intervals throughout prenatal care, such that pregnant people can be connected to resources to alleviate the burden of stressful life events and their impact on maternal and neonatal outcomes. These include financial resources, social support resources, as well as partner-support resources as partner-related stressful life events have demonstrated considerable impact on the outcomes in this study. Interpersonal psychotherapy (IPT) during pregnancy and the postpartum period has been shown to effectively decrease psychological distress as well as symptoms of depression and anxiety and improve coping and social support (Bright et al., 2020). While interventions like these are promising, access to them will be a barrier, thus they need to be matched with systemic programs and policy to expand access, especially for vulnerable populations.

There is a need to expand the standardized questions regarding discrimination and stressful life events in the next iteration of PRAMS to truly understand the impact of psychosocial stress, including discrimination such as racism, on neonatal and maternal health outcomes. While we examined five states, we found significant variance across their outcomes related to prevalence of both reported stressful life events and maternal health outcomes. Our analysis was limited as these questions were state-based add-ons to the PRAMS Phase 8 survey and most states have yet to add questions regarding discrimination and major life events such that the national impact of psychosocial stress on pregnancy outcomes is still unknown. Adding questions from already existing validated scales such as the Mother's Autonomy in Decision Making (MADM) scale and Mothers on Respect index (MORi) to assess the impact of discrimination such as racism in the health care setting on maternal health outcomes would allow for this to be assessed more specifically nationwide (Vedam, Stoll, Martin, et al., 2017; Vedam, Stoll, Rubashkin, et al., 2017). Measurement of the impact of racism and discrimination on maternal health outcomes is necessary, as a large portion of the causes of Black-white racial disparities in maternal outcomes are still unknown are likely related to interpersonal and structural racism (Howell, Egorova, et al., 2020; Howell, Janevic, et al., 2020). Future directions of the impact of psychosocial stress and maternal outcomes need to specifically examine stress due to gendered racism and how it impacts the childbirth experience in order to thoroughly address the impact of psychosocial stress on disparities

in maternal morbidities (Markin & Coleman, 2021). These survey measures need to be standardized for proper comparison across states and for the assessment of the impact on a national level.

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