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The Role of Stress in Racial Disparities of Preterm and Low Birth Weight Births in Georgia

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ABSTRACT

SAIDA SHARAPOVA
The role of stress in racial disparities of preterm and low birth weight births in Georgia
(Under the direction of Richard Rothenberg, MD, MPH)

Preterm birth (PTB) and low birth weight (LBW) are the leading causes of infant deaths in Georgia. Georgia PRAMS data (2004-2008) were analyzed for non-Hispanic White and non-Hispanic Black women with singleton births, using SAS 9.2 survey procedures. Thirteen stressful life events experienced in a year before delivery, socio-demographic, medical and behavioral risks were used as predictors of PTB and LBW. Significant racial disparity in birth outcomes and risks was found. In Whites stressful events were associated with adverse birth outcomes in bivariate logistic regression, but weakened when controlling for other factors (income, education, maternal age, maternal health, alcohol and tobacco use, infant's gender and birth defects). In Blacks, association between stressful events and adverse birth outcomes adjusted for other risks was stronger. Socio-economic factors and mother's health status were more significant in predicting birth outcome. Women's health and SES improvement might increase favorable pregnancy outcomes and reduce racial disparities.

INDEX WORDS: preterm birth, low birth weight, stressful events, Georgia, PRAMS, logistic regression, multiple risks, racial disparity

THE ROLE OF STRESS IN RACIAL DISPARITIES OF PRETERM AND LOW BIRTH WEIGHT BIRTHS IN GEORGIA

BY

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MD, TASHKENT PEDIATRIC MEDICAL INSTITUTE

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APPROVAL PAGE

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DEDICATION

To my husband Umid for his support and encouragement along the way and to my mother for her faith in me and loving care,

Thank you!

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I would like to sincerely thank professors, faculty and staff in the Institute of Public Health at Georgia State University for teaching and guiding me throughout my MPH experience. Me special thanks to my committee members Dr. Gary Nelson from Healthcare Georgia Foundation and Dr. William Callaghan from CDC for their patience and availability and prompt responses to my requests. I am grateful to my chair Dr. Richard Rothenberg without whom I wouldn't be where I am today. I would also like to acknowledge Dr. Chinelo Ogbuanu and Katherine Kahn from Georgia Department of Public Health for providing me with the database, Dr. Jian Xing and Dr. Andrey Borisov from CDC for the help with conducting the analysis. This acknowledgement would not be completed without my sincere thanks to Dr. Michael Eriksen for his kind support of my academic and research endeavors.

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Education

Master of Public Health, January 2011-Present
Georgia State University, Atlanta, GA

Medical Doctor, September 1994-June 2001
Tashkent Pediatric Medical Institute, Tashkent, Uzbekistan

Work Experience

Public Health Analyst, June 2011-May 2012, Atlanta, Ga

Healthcare Georgia Foundation

• Reviewed, evaluated, and analyzed publications on infant mortality and interventions for its reduction.

• Developed and composed Request for Proposals for an intervention to reduce infant mortality in Georgia.

• Tracked public data, trends and programs in maternal and infant health.

• Significantly contributed in reviewing and evaluating contents of scientific documents with the ability to recognize inconsistencies in documents that authors needed to correct.

Faculty member, September 2003-November 2004, Tashkent, Uzbekistan

Tashkent Pediatric Medical Institute

• Provided patient care at Neonatal Intensive Care Unit and Department of Prematurely Born Children.

• Taught neonatology to medical students in small groups.

• Reviewed and translated English publications for the faculty.

Table of contents

List of tables

List of figures

Chapter I

Introduction

Background

Health disparities in the United States are widely recognized but not completely understood (Hauck, Tanabe, & Moon, 2011). The gap between white and minority US populations in infant mortality, preterm births and low birth weights persists despite all the advances in medicine, technology and disease prevention (T. Dominguez, 2011; Mathews & MacDorman, 2008). African American women are at more than 2 times higher risk of infant death compared to White women (Alexander et al., 2003). Higher infant mortality is attributed to higher rates of preterm and low birth weights (Mathews & MacDorman, 2008). Both outcomes are also associated with poorer health and cognitive development of the children and even higher risks of obesity and cardiovascular diseases in adults (Colvin, McGuire, & Fowlie, 2004; Davey Smith, Hypponen, Power, & Lawlor, 2007; Saigal, 2000). It has been established that causes of preterm birth and low birth weight are multiple, including nutritional, infectious, environmental, behavioral, and genetic risk factors (Goldenberg et al., 1996; M. S. Kramer, 2003). Despite the mounting evidence for association of these risks and adverse outcomes, predicting and prevention strategies remain a challenge. As individual-level studies and interventions fail to account for the entirety of the racial gap, social determinants of health and stress start playing larger role in attempts to understand and reduce Black/White disparities in birth outcomes (Fuller, 2000). An array of psychosocial factors, such as life events, depression, and

pregnancy anxiety, perceived discrimination, and neighborhood safety and segregation have been linked to prenatal stress and adverse birth outcomes (Ahluwalia, Merritt, Beck, & Rogers, 2001; Bryant-Borders, Grobman, Amsden, & Holl, 2007; Dailey, 2009; Dunkel Schetter, 2011). This study attempts to contribute to the research of maternal stress and pregnancy outcomes by examining data on stressful life events and their association with PTB and LBW in the state of Georgia.

Purpose of the study

Purpose of this study was to explore stress estimation available from Pregnancy Risk Assessment Monitoring System (PRAMS) and its association with adverse birth outcomes: preterm birth (PTB) and low birth weight (LBW). This study further aims to research racial disparities in adverse birth outcomes and if these disparities can be explained by stress estimates available from PRAMS. PRAMS is an important population-based continuous source of maternal and infant health data for public health. If this study finds significant associations between stress, race, and PTB/LBW, PRAMS may become useful public health instrument to monitor measures to improve birth outcomes.

Research questions

In order to investigate contribution of stress to adverse birth outcomes in different racial/ethnic groups this study aimed to answer the following research questions:

1. What estimate of stress level is available from PRAMS data?
2. Is there racial/ethnic disparity in stress estimates available from PRAMS?
3. Does stress during pregnancy predict PTB and LBW?

4. Does stress during pregnancy predict PTB and LBW when controlling for known effect modifiers and confounders?
5. Is there racial/ethnic disparity in the predictive value of stress?

Chapter II

Literature Review

This chapter presents review of scientific literature on epidemiology and risk factors of low birth weight and preterm birth, as well as physiological pathways, measurement, and conceptual frameworks linking stress during pregnancy and adverse pregnancy outcomes. Special attention was paid to publications examining racial disparities in stress and adverse pregnancy outcomes of interest: low birth weight and preterm births.

Methods of literature review

Literature review was conducted through the US National Library of Medicine of the National Institutes of Health (PubMed) database. Several searches used different combinations of the following descriptors: stress, pregnancy, birth outcome, pregnancy outcome, low birth weight, preterm, premature, race, disparity. Initial searches revealed 126,675 citations. To narrow the selection, search was limited to the publications within the last ten years, in English, and related to humans only. Search with "stress" AND "pregnancy" AND "low birth weight" resulted in 557 citations. Combination of "stress" AND "pregnancy" AND "preterm" discovered 695 citations, and combination of "stress" AND "pregnancy" AND "premature" discovered 919 citations. Thirty one more citations were found by the search with "stress" AND "pregnancy" AND "disparity". Finally, searching by "preterm" OR "low birth weight" AND "disparity" 229 citations were found. Abstracts relevant to the understanding the role of stress in pregnancy, its Black/White differences and associations with low birth weight and preterm births were

selected for the review of the full texts. References from these citations were subsequently reviewed in order to identify relevant publications.

Low birth weight and preterm births

Low birth weight and preterm births are key adverse pregnancy outcomes, as they are believed to be major contributors to infant mortality. In the overview of fetal and infant mortality and preterm births in the United States MacDorman (2011) lists disorders related to short gestation and low birth weight as a second leading cause of infant deaths for American babies, except for the non-Hispanic Blacks for whom these disorders are the first leading cause of death. Infant born with

In the comprehensive list of objectives for improving health of all Americans Healthy People 2020, a nationwide 10-year agenda, has two that target low birth weight and preterm birth. Maternal, Infant, and Child Health objectives aim to reduce rate of low birth weight births from 8.2 percent registered in 2007 to 7.8 percent in 2020; and to reduce preterm birth rate from 12.7 percent in 2007 to 11.4 percent in 2020 (United States Department of Health and Human Services, 2012).

International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) defines ***low birth weight*** as weight at birth less than 2,500 g (5 pounds, 8 ounces), and ***preterm birth*** as less than 37 completed weeks of gestation (World Health Organization, 2008).

Low birth weight as a diagnosis reflects a common outcome of two different pathological processes: short gestation (preterm birth) and impaired fetal growth due to intrauterine growth retardation (IUGR) or congenital defects (M. S. Kramer, 2003). This

means that an infant can have low weight because of being born too early and haven't yet reached the normal birth weight limit. At the same time, low birth weight can be due to nutritional deficit and underdevelopment. Such a baby will be lighter than a baby born at the same gestational age but having adequate growth rate. In fact, an infant can be both premature and growth-impeded. To differentiate IUGR from prematurity small for gestational age (SGA) outcome is increasingly used (Ahluwalia, et al., 2001; Engel et al., 2005). SGA is defined as having birth weight less than 10^{th} percentile for the gestational week (World Health Organization, 2008). Measuring gestational age is complicated by inaccuracies in identifying of the date of the last menstrual period. Though ultrasound examination is able to accurately determine gestational age, it is not readily available. Thus, LBW is still used and reported as precise and accurate measurement of birth outcome (M. S. Kramer, 2003).

Many factors contribute to the low birth weight. Multiple pregnancies are subject to biological restrictions of gestation and growth, so they are usually excluded from the studies of LBW causes. Back in 1987 Kramer identified 43 factors influencing birth weight, including infant gender, race, maternal stature, maternal weight gain during pregnancy, socio-economic status (SES), parity, pregnancy interval, prior birth outcomes, infections, tobacco and alcohol consumption, caffeine consumption, illicit drugs, quality and quantity of prenatal care visits, etc. (M. S. Kramer, 1987). These and additional factors are confirmed as LBW risks by subsequent independent studies for example, Dietz et al., 2010; Dunlop et al., 2008; Kempe et al., 1992; Mariscal et al., 2006 .

Trend in the rate of LBW in the US by race/ethnicity is presented in . It demonstrates steady, though slow, increase between 1980 and 2006, and then slight decrease.

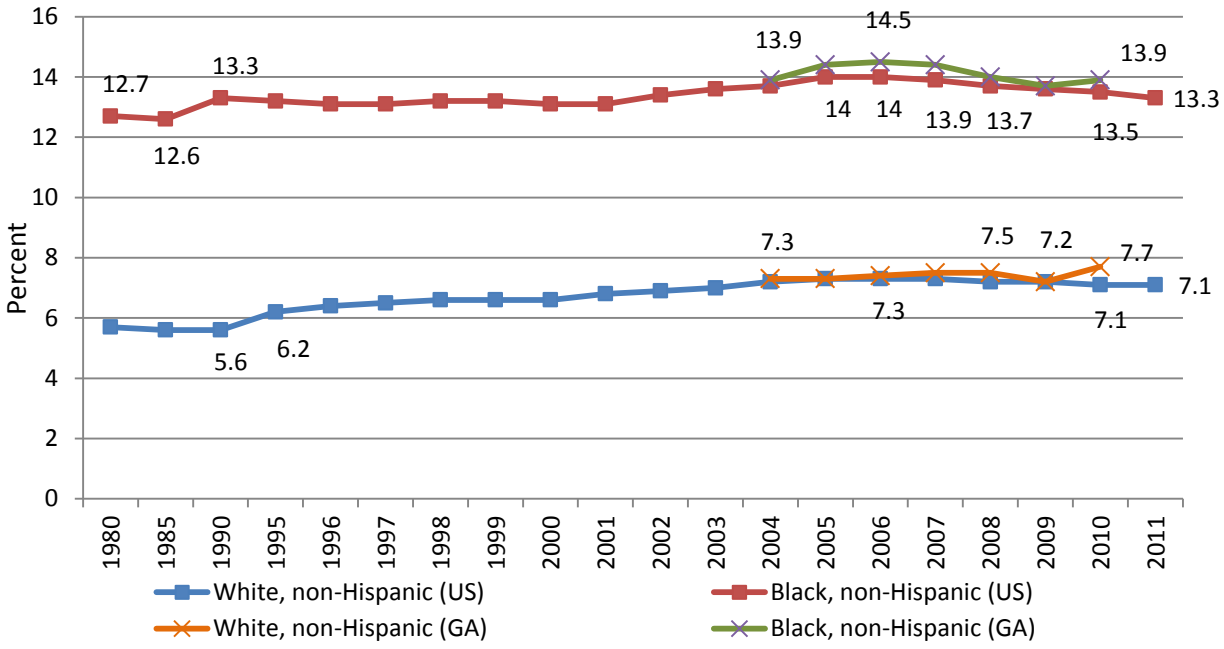
Black/White gap remains practically the same for three decades (Child Trends Data Bank, 2012). In Georgia the trend generally parallels the US, except that the rate for non-Hispanic Blacks grows faster between 2004 and 2006 reaching peak 14.5 percent. Also, Georgia rate goes up for both Whites and Blacks in 2010: to 7.7 and 13.9 percent respectively (Georgia Department of Public Health, 2012). At the same time, rates of singleton low birth weight births and very low birth weight births (less than 1,500 g) remained practically stable through the last three decades. Research of linked birth and infant death data indicates that rise in multiple births and Cesarean sections due to better monitoring of high risk pregnancies partially explain the increase in LBW births (Mathews & MacDorman, 2008).

Preterm or premature births constitute a growing public health problem in the US. It has been estimated that in 2005 costs of preterm birth related expenses amounted to $26.2 billion (Institute of Medicine, 2007). It is a single most important cause of infant deaths, accounting up to one third of infant mortality (Callaghan, MacDorman, Rasmussen, Qin, & Lackritz, 2006). Long term consequences for the survivors of preterm births include, but are not limited to the conditions like cerebral palsy, hearing loss, vision problems, intellectual disabilities, and respiratory problems (Colvin, et al., 2004; Gilbert, Nesbitt, & Danielsen, 2003). Risk factors for prematurity are similar to those for low birth weight: multiple pregnancy, chronic health problems, infections, cigarette smoking, and alcohol or illicit drug use during pregnancy. Specific risk factors are associated with maternal reproductive system: cervical insufficiency, premature rapture of membranes, uterine overextension, vaginal bleeding, and placental disorders (Erickson et al., 2001; Goldenberg, et al., 1996). Preterm birth can happen spontaneously or be medically

induced. Reasons for medical induction may be elective Cesarean section or medical problems requiring termination of pregnancy (Erickson, et al., 2001).

Rate of preterm births has been growing from 1980s to 2004 reaching 12.5% (MacDorman, Callaghan, Mathews, Hoyert, & Kochanek, 2007). Infant mortality related to prematurity is 3.5 times higher in non-Hispanic Blacks than in Whites. And it was even higher than total infant mortality rate in non-Hispanic White, Mexican, and Asian/Pacific Islander babies (ibid).

Figure 1. Trends in low birth weight births in the US and Georgia



Data include singleton and multiple births.
Data for 2011 is preliminary.
Data source: Child Trends Data Bank. Low and very low birth weight. Available from http://www.childtrendsdatabank.org/sites/default/files/57_Low_Birth_Weight.pdf
Georgia Department of Public Health. (2012). Maternal/Child Health Web Query. OASIS. Retrieved November 13, 2012, from Georgia Department of Public Health, Office of Health Indicators for Planning. http://oasis.state.ga.us/oasis/oasis/qryMCH.aspx

Racial disparities in birth outcomes.

Persisting **racial disparities** in birth outcomes and infant mortality are the major public health concern in USA (Hauck, et al., 2011). Greater infant mortality in disadvantaged minority populations is attributed to greater incidence of preterm and low birth weights, birth defects, sudden infant death syndrome, and unintentional injuries. Multifactorial complex nature of adverse birth outcomes encompasses interactions of social, behavioral, environmental, genetic, health care access and utilization, political and biological influences. Disparities in outcomes often reflect differences in risks. Thus low socio-economic status (SES) is associated with multiple risk factors that influence birth outcomes, and minority populations often have low SES (M. S. Kramer, Séguin, Lydon, & Goulet, 2000). However, this rule has its exception. So called Hispanic paradox refers to more favorable birth outcomes and lower infant mortality in Mexicans and other immigrants from Latin America despite very low SES and multiple risks (R. Hummer, Powers, Pullum, Gossman, & Frisbie, 2007). The paradox is often explained by tight family and community bonds and cultural background of Hispanics. This hypotheses is confirmed by decline in health and increase in adverse outcomes among immigrants who have been staying in the US for 5-6 years and longer and have assimilated in the American culture (R. A. Hummer & et al., 1992). For the sake of excluding of the Hispanic paradox influence on research results, it is an established practice to separate studied subpopulations by race and Hispanic ethnicity (Bruckner, Saxton, Anderson, Goldman, & Gould, 2009; T. P. Dominguez, Dunkel-Schetter, Glynn, Hobel, & Sandman, 2008; Hauck, et al., 2011; MacDorman, 2011).

Several theoretical frameworks have been formulated to explain racial disparities in birth outcomes: life history model, ‘weathering’, and maternal stress hypothesis among them.

Life history theory provides framework for understanding how evolutionary adaptations to changing environmental conditions affect reproductive capacity of women. For example, unfavorable environmental conditions reduce ‘somatic investment’ of a woman, i.e. makes a woman’s body reluctant to provide nutrition to a fetus as resources are more important for her own survival (Kruger, Munsell, & French-Turner, 2011).

‘Weathering’ explains early health deterioration of young adult African American women due to social inequality and discrimination (Geronimus, 1996; Love, David, Rankin, & Collins, 2010).

Maternal stress

The maternal stress hypothesis focuses on two periods of psychosocial stress (C. J. R. Hogue & Bremner, 2005a). One is a life-course exposure to stressors that begins long before conception, and has more of a chronic nature. Second is acute prenatal stress, which may involve pregnancy-related anxiety or stressful life events, such as divorce or death of a close person. (M. R. Kramer & Hogue, 2009).

Mediating processes between stress in pregnancy and birth outcomes include three possible mechanisms: neuroendocrine, inflammatory/immune, and behavioral (Hobel, Goldstein, & Barrett, 2008).

Neuroendocrine-mediating processes are based on activation of maternal hypothalamic-pituitary-adrenal (HPA) axis (a basic biological system of response to

stress by releasing various hormones of 'fight or flight' reaction). As a result, placenta starts producing more and more placental corticotropin- releasing hormone (pCRP), which initiates a cascade of effects resulting in early labor (Dunkel Schetter, 2011).

Inflammatory and immune-mediating processes involve activation of inflammatory pathways by stress hormones, infections, periodontal disease, and the like. Inflammatory reactions include an increased production of inflammation specific chemicals: cytokines, C-reactive protein, and other complex responses again resulting in early labor (Dunkel Schetter, 2011; M. R. Kramer & Hogue, 2009).

Finally, **behavioral mediating processes** incorporate coping with stress by substance use (tobacco, alcohol, and illicit drugs), poor nutrition, lack of exercise and their respective pathways to adverse birth outcomes. On the other hand, physical exertion because of physically demanding work has been also associated with PTB and LBW (Dunkel Schetter, 2011).

If mechanisms of stress-related health effects are well-formulated, **measuring stress** presents a challenge. Maternal stress is defined as stressful events or conditions ('stressors'), perceptions or evaluations of stressors ('appraisals'), and stress responses (Lobel, 1994). Maternal stress includes a variety of exposures: stressful life events, catastrophes, chronic strain, neighborhood stress, and pregnancy-specific anxiety, all capable of independently contribute to the risk of PTB and LBW (Dunkel Schetter, 2011). Alderdice (2012) in the review of prenatal stress measures identified 15 of them. Three scales targeted specific populations: high risk women, women who had previously lost a baby, and South Asian women. Two scales were excerpts from longer instruments,

and ten were pregnancy-specific scales for general population. The reviewer stated that all of the measures were focusing on some aspects of stress and not on all of them, so the choice of a scale should be based on research questions. Timeframe of interest was important to consider too, as some scales asked about current events, while others refer to the entire year. The author does not recommend retrospective recall of prenatal stress after some time since delivery. Nevertheless, there are a number of brief user-friendly scales that can be practical in clinical and public health settings. (Alderdice, et al., 2012).

Coping, or cognitive and behavioral efforts to manage stress must be considered alongside with the stress level. Coping mechanisms may modify stress effects on the birth outcomes, or suppress and minimize occurrence of stress (Dunkel Schetter, 2011). Maternal personality plays important role in determining stress reactions and coping behaviors (Chatzi et al.; Dole et al., 2003). Coping works in different positive and negative ways, like distancing from stressors, turning to substance abuse, or rationalizing and minimizing stress (Hamilton & Lobel, 2008).

Social support from family, partner or husband, friends, or community; woman's cultural background, timing of stress experience during the pregnancy are all important considerations affecting stress-related outcomes (Dunkel Schetter, 2011).

From numerous studies of maternal stress come inconsistent results of association with PTB and LBW. Evidence connects major stressors, like life events and preterm births. As for the association with low birth weight, it was more strongly predicted by chronic stressors, i.e. living in crowded conditions, or being unemployed (Bryant-Borders, et al.,

2007). Perceived racism and discrimination is one kind of a chronic stress (T. P. Dominguez, et al., 2008; T. P. Dominguez, Schetter, Mancuso, Rini, & Hobel, 2005).

Interpreting associations of stress and birth outcomes should be careful, as stress is highly correlated with SES (N. S. Whitehead, Brogan, Blackmore Prince, & Hill, 2003) and depression (Jackson, Rowley, & Curry Owens, 2012), and may be confounded.

Rationale for this study.

While conducting literature review I haven't seen a study that would examine influence of maternal stress on birth outcomes in the context of multiple well-known risks of PTB and LBW. Also, there were few studies of maternal stress conducted in the state of Georgia. Georgia has relatively large proportion of African American population and widening gap between Black and White birth indicators. This study was planned as an attempt to illuminate some of interactions between prenatal stress, preterm births, low birth weight and race/ethnicity in Georgia.

Chapter III

Methods and Procedures

Data source

Data for this study were provided by Georgia Pregnancy Risk Assessment Monitoring System (PRAMS). PRAMS is a multistate ongoing surveillance program established in 1987. It obtains information on the health of mothers and infants, i.e. obstetric history, prenatal care, maternal use of alcohol and cigarettes, physical abuse, contraception, economic status, maternal stress, early infant development, breastfeeding, vaccinations, and safety practices. Each state participating in PRAMS draws a stratified random sample of 100 to 250 women who have recently delivered a live infant. Selection of survey respondents is conducted every month based on birth certificate data. Selected women receive a letter with the instructions and the questionnaire. Women, who don't respond to the letter, are reached by a phone interview. Multiple reminders and contact attempts are employed alongside with incentives in order to increase participation. Informed consent is obtained before administering the survey. Standard protocol of data collection procedures and instruments ensures comparability between states and data quality (Centers for Disease Control and Prevention, 2012b).

PRAMS topics and questions are extensively researched and pretested before being included in the survey. Core questions are the same for all states. There is also a pool of pretested standard questions from which participating states choose additional questions to adapt the survey to the state's needs. States can also develop their own questions.

Questionnaires are available in English and Spanish. Survey responses are supplemented by demographic and medical information from the birth certificates (Centers for Disease Control and Prevention, 2012d).

The collected data are weighted to adjust for the sampling, non-response, and non-coverage. The product of three weights is used as analysis weight, which represents the number of women like the respondent in the population the respondent represents. Complex sampling design of PRAMS data requires use of specialized analytic software (Centers for Disease Control and Prevention, 2012b). PRAMS data are available to researchers by request to CDC for multistate studies or to the state's PRAMS coordinator for single-state data. CDC PRAMS web site www.cdc.gov/prams provides detailed information on PRAMS design, methodology, protocols, questionnaires, dataset codebook, as well as instructions for single-year and multi-year analysis, publications, and some tabulated data.

Currently 40 states and New York City participate in PRAMS (Centers for Disease Control and Prevention, 2012c). Georgia PRAMS started in 1991 and is conducted by the Office of Health Indicators for Planning and Maternal and Child Health Epidemiology Section with support from the Maternal and Child Health Branch of the Georgia Department of Public Health (DPH). In addition to the core questions Georgia PRAMS collects information on prenatal care visits, breastfeeding, Group B Streptococcus, HIV testing and awareness, folic acid use, influenza vaccination during pregnancy, post-partum depression, infant sleeping position, and hearing screening of newborns. Survey respondents are oversampled on low birth weight and Black race to achieve adequate sample size of high risk groups. So, Georgia PRAMS data are stratified by race and birth

weight in to four groups. The data are collected over an entire year, and then weighted to represent the state population and account for non-response, non-coverage and sampling design. Each stratum should achieve at least 70% weighted response rate to minimize bias. Data for this study were provided from the fifth phase (revision) of the Georgia questionnaire including years 2004 through 2008. Phase V was chosen because of consistently high response rate and absence of significant changes in questionnaires and birth certificate format over the period.

In 2004 two strata were below 70% - Black Low Birth Weight and Black Normal Birth Weight. In other years all strata have achieved 70% or higher response rate (Hoban, Goodman, & Wu, 2007). Since 2007 response rate threshold was decreased to 65% (Centers for Disease Control and Prevention, 2012a).

In order to obtain data for the study I completed a data request form for Georgia DPH, and received approval from Georgia State University Institutional Review Board. De-identified data contained only variables that I chose for the study based on literature review and DPH staff recommendations. I conducted data cleaning, checked data for consistency, normality, and created a number of categorical variables suited for the planned analysis.

Study population

The Georgia PRAMS data were combined for years 2004 – 2008 resulting in a sample of 7,275 women. Using information on maternal race and Hispanic origin available from birth certificates two main study subpopulations were defined as non-Hispanic Black (referred to as Blacks further in the document) and non-Hispanic White (Whites). Taking

into account that multiple births are biologically determined to be born earlier and weigh less, multiple births were excluded from the analysis. Due to the complex survey nature of the sample it was important to keep all respondents in the sample order to preserve the data structure and accurate results (X. Chen & Gorrell, 2008). Thus data analysis was conducted in two domains: race/ethnicity and plurality. Black-singleton birth group included 3,269 respondents, and White-singleton birth group had 2,430 respondents. Four other subpopulations (Black-multiple birth, White-multiple birth, Other race/ethnicity-singleton, and Other race/ethnicity/multiple births) composed of 1,568 respondents and 8 cases missing plurality information were not considered when presenting and interpreting results of the study.

Dependent variables (DV)

Preterm births and low birth weight were two main birth outcomes for this study. *Preterm births* were identified less as than 37 completed weeks of gestational age provided by birth certificate data. Births at 37 completed weeks and later were categorized as *term*. Information about gestational age was available for birth certificates as difference between date of the last menstruation and delivery date.

Low birth weight births were defined as birth weight less than 2,500 g. *Normal birth weight* births were defined as 2,500 g or more. Birth weight was provided by birth certificate data. 44 infants with birth weight over 4,500 g were included in the analysis.

Given the non-viability of infants born before 20 weeks of gestation and with weight of less than 500 g (Alexander, et al., 2003; Ehrenthal, Wingate, & Kirby, 2011; Partridge,

Sendowski, Martinez, & Caughey, 2012) I excluded these cases from analysis by setting them as missing gestational age and birth weight information.

Independent variables (IV)

PRAMS collects data on 13 stressful life events during the year before delivery, with responses coded as 'yes' or 'no'. These questions are derived from the Modified Life Events Inventory (N. S. Whitehead, et al., 2003).

- A close family member was very sick and had to go into the hospital.
- I got separated or divorced from my husband or partner.
- I moved to a new address.
- I was homeless.
- My husband or partner lost his job.
- I lost my job even though I wanted to go on working.
- I argued with my husband or partner more than usual.
- My husband or partner said he didn't want me to be pregnant.
- I had a lot of bills I couldn't pay.
- I was in a physical fight.
- I or my husband or partner went to jail.
- Someone very close to me had a bad problem with drinking or drugs.
- Someone very close to me died.

I also used two variables constructed by the Georgia DPH: number of reported stressful events and grouped number of stressful events: 1-2 events, 3-5, and more, and none.

Control variables

I considered various demographic, socio-economic, medical and behavioral factors that are known to be associated with preterm births and low birth weight births as effect modifiers and potential confounders. Variables that were available from Georgia PRAMS and birth certificates are described below.

Maternal age was divided into three categories: less than 19, 19-34, and 35 years and older. Dividing 19-34 years age group into smaller categories didn't yield significant changes in either outcomes or independent variables.

Annual family income was categorized as less than $10,000; $10,000-$24,999; $25,000-$49,999; and $50,000 or more.

Marital status was set as married and non-married (including never married, divorced, separated, etc.).

Maternal education was categorized as less than 12 years, 12 years (completed high school) and more than 12 years.

I used dichotomous variables (yes-no) for initiation of prenatal care in the first trimester, intendedness of the last pregnancy, having health insurance before pregnancy, Medicaid enrollment (before or during pregnancy or for delivery), Women Infant and Children (WIC) enrollment, and seeking medical help for depression during pregnancy.

Years since last live birth were used as substitute for inter-pregnancy interval: if a women reported to have zero or one year since last live birth she was categorized as having short inter-pregnancy interval (less than 6 months). Two and more years since last live birth were reported as adequate inter-pregnancy intervals.

Parity had three categories: no previous live birth, one previous live birth, and two or more previous live births. Parity information was available from both PRAMS questionnaire and birth certificate. PRAMS asked respondents if they had previous live birth, and birth certificate provided information on the number of previous live births. I found inconsistency of data such as some women reporting having previous live birth but having zero previous live births in birth certificates, as well as women reporting no previous live birth, but having one or more previous live births in birth certificates. Such cases were set as missing information on parity.

I used the combined variable identifying outcomes of previous pregnancies as no previous live births, normal birth, preterm birth, low birth weight, and preterm birth and low birth weight. This variable was provided as one of analytic variables created by the Georgia DPH based on PRAMS questionnaire. This variable was subject to the same birth certificate-PRAMS data discrepancy. As with parity data, I set inconsistent cases as missing information on previous pregnancy outcomes.

Four maternal body mass index categories were used: normal weight (19.8-26 kg/m^2), underweight (less than 19.8 kg/m^2), overweight (26-29 kg/m^2), and obese (more than 29 kg/m^2).

Alcohol consumption was categorized as not a drinker, low to moderate drinking, and heavy to binge drinking. I used five variables on alcohol consumption available from PRAMS questionnaire: having any alcoholic drink in the past two years, average weekly intake of alcoholic drinks and number of times when respondent had five or more alcoholic drinks in one sitting reported for the three months before pregnancy and in the

last trimester. Not a drinker was defined as a woman who answered ‘no’ to the question about drinking in the last two years or who answered ‘yes’ to this question but reported having less than one drink or not drinking alcohol both before and during pregnancy and who reported never having five or more drinks in one sitting or not drinking alcohol both before and during pregnancy. If a woman reported having five or more alcoholic drinks in one sitting any number of times or having 14 or more drinks a week before or during pregnancy, she was categorized as heavy/binge drinker. Otherwise, if a woman reported average number of drinks per week to be between one and 13 either before or during pregnancy she was considered low-to-moderate drinker.

Smoking in PRAMS questionnaire is also covered by several questions: smoking at least 100 cigarettes in the past two years, average daily cigarettes smoked in the three months before pregnancy and in the last trimester, and current average daily number of cigarettes smoked. I used the first three questions and identified a smoker as someone who replied ‘no’ to smoking in the past two years, or reported zero cigarettes smoked in a day in the three months before pregnancy or in the three last months of pregnancy. Women who reported any number of cigarettes smoked before or during pregnancy were considered as smokers.

PRAMS provided two variables for physical abuse in the year before the last pregnancy and during the last pregnancy. I combined these into one dichotomous variable of physical abuse where presence of physical abuse was identified if a woman had answered ‘yes’ to any one of physical abuse questions, and absence of physical abuse was identified if ‘no’ was answered to both questions.

There were 12 dichotomous (yes-no) variables indicating medical problems during pregnancy: diabetes before and during pregnancy, vaginal bleeding, kidney or bladder (urinary tract) infection, severe nausea, vomiting, or dehydration; incompetent cervix; high blood pressure, including pregnancy-induced hypertension, preeclampsia, or toxemia; problems with placenta, such as abruption placentae or placenta previa; preterm or early labor; premature rapture of membranes (PROM); blood transfusion; and being hurt in a car accident. As vaginal bleeding, incompetent cervix, problems with placenta, early labor, and PROM are in their nature preterm births, they were excluded from the analysis. Remaining variables were combined in a high risk pregnancy variable, which was coded as 'yes' if any one of the medical problems was present and 'no' if none of medical problems were reported.

Four PRAMS questions asked about being hospitalized or on bed rest due to medical problems and duration of hospitalization. Each of them was significant in predicting both PTB and LBW. As hospitalization reflects severity of a medical risk, but not its nature, they were ultimately excluded from analysis.

Children related variables used were birth defects (yes-no) and gender.

Some of the variables were available as both continuous and categorical: maternal age, maternal BMI, birth weight, gestational age, years since last live birth, number of previous live births, and number of reported stressful events.

Statistical analysis

Analysis of complex sample survey data requires specified statistical software. At present four statistical packages are considered appropriate for the task: SUDAAN, STATA,

SPSS, and SAS (Siller & Tompkins, 2005). I used SAS (version 9.2 SAS Institute, N.C.) survey procedures for the analysis. Each procedure took into account stratified sampling design, the analysis weight, and the correction for finite population. All analyses were conducted by domains of race/ethnicity and plurality. Missing values were excluded from calculations involving those events. Variance estimation was conducted using Taylor series linearization. Wald chi square was used for all chi square tests, as recommended by SAS manual for survey analysis (SAS Institute Inc, 2008). Descriptive statistics were obtained for continuous variables of maternal age, maternal BMI, birth weight, and gestational age. Means, medians, standard errors, confidence intervals for means, minimum and maximum values, and associated p-values were obtained for all continuous variables. Cross-tabulation of categorical independent variables produced distribution of categorical variables in study groups, Wald chi square test for independence between race/ethnicity and independent variables, independent variables and birth outcomes, correlations between variables, confidence intervals and associated p-values.

I then proceeded to bivariate logistic regression to find associations of independent variables and birth outcomes. Variables with significant ($p<.05$) coefficients and 95% confidence intervals (CI) of crude odds ratios (OR) (not including 1) were selected for multivariate logistic regression. Selected variables differed for preterm births and low birth weight births. More variables were associated with LBW, than PTB. This was expected as LBW includes both prematurity and intrauterine growth retardation with different pathways and risk factors. Use of an outcome that describes "small for gestational age" is increasingly used to distinguish intrauterine growth retardation from preterm birth (Jao et al., 2012; Savitz, Stein, Siega-Riz, & Herring, 2011).

For the multivariate logistic regression I choose variables that were well-known risk factors for PTB and LBW, and had p-value of at least .05 in bivariate logistic regression. I found that previous adverse birth outcomes and hospitalization during pregnancy were strongly associated with both preterm births and low birth weight births. This finding corresponds to previous studies on risks of adverse birth outcomes (Chao et al., 2010; Davey, Watson, Rayner, & Rowlands, 2011), however it only indicates that a woman belongs to a high risk group without providing insight to the nature of the risks. Although these variables are significant and important predictors of adverse birth outcomes, I decided not to include them in the multivariate logistic regression models as collinear.

I started each multivariate logistic regression with a model including all selected variables and eliminating one least significant by Wald chi square and its p-value in the backwards elimination stepwise process. I controlled c-statistics of fit for each model. Final model was selected based on maximum c-statistics and maximum number of significant IV. I then checked for interactions between selected variables in order to identify possible effect modifiers. Next chapter presents results of these calculations.

Chapter IV

ResultsTable 2 demonstrates that Blacks are significantly more likely to experience certain events, i.e. more arguing with the significant other, unpaid bills, death in the family, divorce, physical fight, homelessness, jail, loosing job, and having pregnancy that is unwanted by her partner. White respondents more often than Blacks reported drinking or drug problems of significant others and serious illness in the family. Moving to a new address appears to be the most and equally frequent stressful event in both study groups. Three other most often stressful experiences reported by Whites were illness of a family member, increased arguing with partner, and unpaid bills. In Black group these events were also the most frequently reported but had different order: arguing, unpaid bills, and illness in the family. Homelessness and physical fights were the less frequent in both groups. On average, Blacks were more likely to report three or more events, and Whites were more likely to report none or 1-2 events. Birth outcomes distribution in study groups is presented in Table 3. Chi square test indicates strong association of adverse birth outcomes and maternal race/ethnicity ($p<.0001$). Of all White babies 90.9% were term and 9.1% were preterm. Of all Black babies 87.1% were term and 12.9% were preterm. Based on the 95% confidence intervals, proportion of preterm birth in Blacks is significantly higher than in Whites. Risk of being born with low birth weight in Black population is comparable with the risk of PTB (12.3% and 12.9% respectively). In White population there is higher risk of PTB than LBW (9.1% and 5.6% respectively). Black/White risk ratio for PTB is 1.4, and for LBW it is 2.2.

Of 13 stressful events none had significance in predicting preterm births (Table 4), except three events that significantly increased odds ratio in White group. These events are: arguing with the partner more than usual, getting separated or divorced, and being unable to pay bills. They were included in the initial multivariate logistic regression model.

Stressful events had more association with low birth weight than with preterm birth (Table 5). Every stressful event increased odds of LBW in White group, though 95% confidence intervals for ORs were not significant for death in the family, family member being very sick, and having physical fight. Arguing more than usual, unpaid bills, alcohol/drugs problems, divorce, jail, loosing job, moving, and pregnancy unwanted by partner were significant predictors of LBW births in bivariate logistic regression.

In Blacks associations of stressful events and low birth weight were weaker and sometimes inverse. Only going to jail was significant predictor of LBW ($p<.05$), but the relationship had protective nature. Also having alcohol/drugs problem in the family and moving to a new address yielded $OR<1$, however 95% CI were not statistically significant. Remaining stressful event in Black group had LBW crude odds ratios slightly above one and insignificant 95% CI.

Table 6 presents results of bivariate logistic regression for preterm births in Black and White study groups. Only variables that yielded significant association were included in the table. Maternal age of less than 19, short inter-pregnancy interval, hypertension, diabetes during pregnancy, and blood transfusion increased odds of PTB in Blacks. Annual family income of $10,000-24,999 was protective ($p<.01$), as was, unexpectedly, low-to-moderate alcohol consumption ($p<.05$) compared to nondrinkers.

In Whites income less than $10,000; as well as being not married, having less than high school education, short inter-pregnancy interval, hypertension, diabetes during pregnancy, severe nausea, blood transfusion, smoking, birth defect, and male gender of the child significantly increased odds of PTB. No variables yielded protective effect.

Independent variables associated with low birth weight births are presented in Table 7. As with stressful events, more variables were predictive of LBW. Income less than $10,000, absence of health insurance before pregnancy, Medicaid, non-married status, less than high school education, high blood pressure, severe nausea, blood transfusion, and birth defect increased odds on LBW in both study populations, though less so in Blacks. Early initiation of prenatal care was protective in both groups ($p<.05$). Also, in Black group being a first time mother and female gender of child increased crude OR for LBW ($p<.05$). In Whites any income below $50,000 increased crude OR for low birth weight. WIC enrollment was also significant predictor of LBW in Whites, as well as high school or less education, unintended pregnancy, short inter-pregnancy interval, being underweight, smoking, and having three or more stressful life event during pregnancy significantly increased crude OR for LBW. Low-to moderate alcohol consumption decreased crude OR 0.73 times compared to being nondrinker ($p=0.1943$).

Initial multivariate logistic regression for preterm birth included arguing more than usual, divorce/separation, and being unable to pay bills, along with maternal age, income, marital status, education, interval since the last live birth, alcohol consumption, smoking, diabetes during pregnancy, high blood pressure, blood transfusion, sex of the infant and birth defects in infant. After backwards stepwise selection only stress related to divorce or separation remained in the final model as significant in the Black group, though not in

the total sample or White group. The final model was adjusted for maternal age, income, and education, interval since the last live birth, alcohol consumption, and diabetes during pregnancy, high blood pressure, blood transfusion, and birth defect of the child. Adjusted odds ratios and 95% confidence intervals for odds ratios are presented in Table 8. The final model accounted for 64.3% of variation in PTB in Blacks and for 67.3% in Whites.

Analysis of two-way interactions between independent variables didn't identify interactions that were significant in the final model.

Final multivariate logistic regression model for low birth weight explained 68.1% of variation in LBW in Black group and 72.3% in White group. It is presented in Table 9 below. Stressful events remained significant only in Blacks: divorce/separation significantly increased adjusted OR, while alcohol/drugs and partner of respondent or herself going to jail decreased adjusted OR. In Black group diabetes before pregnancy and blood transfusion increased adjusted OR, while obesity and male gender of infant decreased odds for LBW.

In contrast, in Whites income below $50,000/year and being underweight increased adjusted OR, whereas heavy/binge drinking decreased adjusted OR but wasn't significant in the model. In both study groups short inter-pregnancy interval and high blood pressure significantly increased adjusted odds of LBW ($p<.05$ and $<.0001$).

Adding or removing variables to the final model didn't change adjusted ORs or significance of remaining variables, but it decreased proportion of variability in LBW explained by the model (c-statistics).

Selective two-way interactions between independent variables were investigated. Interactions between going to jail, drinking/drug problem, income, and education were not significant.

In summary, none of the stressful events were associated with adverse birth outcomes in Whites, when adjusted for SES and health indicators. In Blacks, results showed that getting divorced or separated in the year before delivery increased odds of preterm and low weight births, whereas stress due to going to jail or drinking/drugs problems in the family decreased odds of low birth weight, controlling for a number of other risks. Significant predictors differed for PTB and LBW, and for Blacks and Whites. Blacks' birth outcomes were more likely to be affected by mother's health (age, medical conditions). Whites were more sensitive to SES along with mother's health (income, education, medical conditions). Chapter V provides further discussion on these findings.

Table 1Table 1 presents descriptive statistics of Georgia PRAMS non-Hispanic Black and non-Hispanic White mothers, who recently delivered a single live infant (categorical variables) as number of respondent reporting the event, weighted proportions, 95% confidence intervals for proportions, and p-values for chi square test for independence between race/ethnicity and events.

Blacks were on average younger than Whites, with higher proportion of very young mothers (less than 19 years old), and fewer mothers of 35 and older age. Respondents' age ranged from 13 to 49 years old with mean age in Black group 25.7 years (SE 0.2013), and from 13 to 45 years in White group with mean age 27.6 years (SE 0.1738).

Annual income was significantly associated with race/ethnicity ($p<.0001$). 39.5% of Black women reported income of less than $10,000 (only 12.6% of Whites). Distribution of different income categories within study groups was reciprocal: about two thirds of Black women reported low income (less than $25,000) and about two thirds of White women reported higher income ($25,000 and more), with majority of White women having $50,000/year (47.3%). Consistently with having lower income, Blacks were more likely dependent on public healthcare resources: WIC and Medicaid, and more often had no health insurance before pregnancy, compared to Whites.

Educational attainment paralleled income distribution: two thirds of Black women completed high school or less, whereas two thirds of White women achieved more than high school education. Significantly more Blacks than Whites never finished high school, and only 40.5% have higher education.

In addition to socio-economic strain, Black women were about twice more likely than White to be not married and to have unintended pregnancy. Inter-pregnancy interval is likely to be less than six months in 14.5% of Blacks and only 9.8% of Whites. Nevertheless, majority of women start prenatal care in the first trimester: 70.9% of Blacks and 85% of Whites (significant difference based on 95% confidence intervals).

Predominant proportions of women in both groups were first time mothers (39.2% Blacks and 45.2% Whites). Whites were more likely to have only one previous live birth, whereas Blacks were more likely to have two or more, but with a small margin. As for the outcomes of previous pregnancies, Blacks times more often had previous low birth weight, preterm birth or both, compared to Whites. Blacks were two times more likely to report having previous low birth weight birth than Whites (10% and 4.9% respectively; data not presented in tables). The difference was found significant at the level of .0001 based on Rao-Scott chi square test for homogeneity. Proportion of previous preterm births is significantly higher in Blacks (7.9%) than in Whites (4.5%); (data not presented in tables). At the same time, proportion of normal previous live births was statistically not different between groups.

Black women were on average overweight (mean BMI 27.2 kg/m^2, SE 0.234), and White women were on average normal weight (mean BMI 25.2 kg/m^2, SE 0.1733). By chi square test for independence there is significant association between BMI categories and race/ethnicity ($p<.0001$). More Black women are obese and overweight, and more White women are normal weight and underweight.

Alcohol consumption was also associated with race/ethnicity ($p<.0001$). Blacks generally report less alcohol consumption, as well as lighter consumption when reported. Similarly, in Georgia PRAMS dataset Blacks are less likely to be smokers than Whites. Both Black and White respondents reduced smoking during pregnancy. In Blacks proportion of smokers in the three months before pregnancy was 9.6%, and in the last three month of pregnancy it was 5.2%. In Whites proportion of smokers changed from 26.8% to 13.8% (data not shown in tables). Associations were significant at the level of $p<.0001$.

Distribution of medical problems during pregnancy was independent of race/ethnicity except for the car accident-related injury (3.1% in Blacks, 2% in Whites, $p<.01$). Significance <.0001 registered for high blood pressure is associated with Hispanic ethnicity, that is two times less likely to have hypertension (data not shown). However, Blacks reported more hospitalization/bed rest than Whites ($p<.0001$).

Whites significantly more often were seeking medical help for depression during pregnancy than Blacks ($p<.0001$). At the same time, Blacks were significantly more likely to be physically abused ($p<.001$) and had significantly more stressful life events reported than Whites ($p<.001$).

Gender distribution among newborns in racial/ethnic groups was equal. Also, there was no association of birth defects and race/ethnicity ($p=0.6579$). Four and a half percent of cases were missing data on birth defect.

Table 2 demonstrates that Blacks are significantly more likely to experience certain events, i.e. more arguing with the significant other, unpaid bills, death in the family, divorce, physical fight, homelessness, jail, loosing job, and having pregnancy that is

unwanted by her partner. White respondents more often than Blacks reported drinking or drug problems of significant others and serious illness in the family. Moving to a new address appears to be the most and equally frequent stressful event in both study groups. Three other most often stressful experiences reported by Whites were illness of a family member, increased arguing with partner, and unpaid bills. In Black group these events were also the most frequently reported but had different order: arguing, unpaid bills, and illness in the family. Homelessness and physical fights were the less frequent in both groups. On average, Blacks were more likely to report three or more events, and Whites were more likely to report none or 1-2 events. Birth outcomes distribution in study groups is presented in Table 3. Chi square test indicates strong association of adverse birth outcomes and maternal race/ethnicity ($p<.0001$). Of all White babies 90.9% were term and 9.1% were preterm. Of all Black babies 87.1% were term and 12.9% were preterm. Based on the 95% confidence intervals, proportion of preterm birth in Blacks is significantly higher than in Whites. Risk of being born with low birth weight in Black population is comparable with the risk of PTB (12.3% and 12.9% respectively). In White population there is higher risk of PTB than LBW (9.1% and 5.6% respectively). Black/White risk ratio for PTB is 1.4, and for LBW it is 2.2.

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Initial multivariate logistic regression for preterm birth included arguing more than usual, divorce/separation, and being unable to pay bills, along with maternal age, income, marital status, education, interval since the last live birth, alcohol consumption, smoking, diabetes during pregnancy, high blood pressure, blood transfusion, sex of the infant and birth defects in infant. After backwards stepwise selection only stress related to divorce or separation remained in the final model as significant in the Black group, though not in the total sample or White group. The final model was adjusted for maternal age, income, and education, interval since the last live birth, alcohol consumption, and diabetes during pregnancy, high blood pressure, blood transfusion, and birth defect of the child. Adjusted odds ratios and 95% confidence intervals for odds ratios are presented in Table 8. The final model accounted for 64.3% of variation in PTB in Blacks and for 67.3% in Whites.

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low weight births, whereas stress due to going to jail or drinking/drugs problems in the family decreased odds of low birth weight, controlling for a number of other risks. Significant predictors differed for PTB and LBW, and for Blacks and Whites. Blacks' birth outcomes were more likely to be affected by mother's health (age, medical conditions). Whites were more sensitive to SES along with mother's health (income, education, medical conditions). Chapter V provides further discussion on these findings.

Table 1. Distribution of study variables. Georgia PRAMS, 2004-2008.

Study variables	Non-Hispanic Blacks				Non-Hispanic Whites				P-value
	Resp.	Wtd. %	95% CI for %		Resp.	Wtd. %	95% CI for %		
Maternal age categories									<.0001
<19	366	12.6	10.3	15.0	129	5.4	4.1	6.7	
19-34	2548	77.2	74.5	80.0	1930	79.6	77.4	81.8	
35+	355	10.1	8.4	11.9	371	15.0	13.1	17.0	
Annual family income									<.0001
< $10,000	991	39.5	36.0	43.0	316	12.6	10.6	14.6	
$10,000 - $24,999	742	29.2	26.0	32.3	421	18.3	15.9	20.6	
$25,000 - $49,999	433	15.5	13.1	17.9	475	21.8	19.4	24.3	
$50,000 or more	395	15.9	13.4	18.4	914	47.3	44.3	50.2	
No health insurance before pregnancy	1866	56.2	53.1	59.3	939	35.4	32.7	38.0	<.0001
Enrolled in Medicaid	2480	75.9	73.3	78.5	1133	42.9	40.2	45.7	<.0001
Enrolled in WIC	2263	71.6	68.8	74.4	931	36.3	33.6	39.0	<.0001
Not married	2204	68.1	65.3	70.8	607	24.3	21.8	26.8	<.0001
Education									<.0001
<12 years	574	19.5	16.9	22.2	339	13.7	11.7	15.8	
12 years	1251	40.0	36.8	43.1	688	28.5	25.9	31.0	
>12 years	1330	40.5	37.5	43.6	1309	57.8	55.0	60.6	
Pregnancy unintended	2114	66.4	63.5	69.4	954	38.6	35.8	41.3	<.0001
Less than 6 months since previous pregnancy	236	14.5	11.1	17.8	138	9.8	7.5	12.0	0.0755
Parity									<.0001
No previous live births	1301	39.2	36.0	42.3	1093	45.2	42.4	48.0	
1 previous live birth	838	29.8	26.9	32.8	702	32.1	29.5	34.8	
2+ previous live births	861	30.9	27.9	33.9	504	22.7	20.3	25.0	
Outcome of previous pregnancy									<.0001
No previous live births	1301	40.3	37.1	43.5	1093	46.2	43.4	49.1	
Previous LBW	203	6.1	4.7	7.5	72	2.4	1.6	3.3	
Previous PTB	133	3.9	2.6	5.1	81	2.2	1.4	2.9	
Previous LBW and PTB	217	4.6	3.4	5.8	127	2.4	1.6	3.2	
Normal previous live birth	1067	45.1	41.8	48.4	874	46.8	43.9	49.6	
PNC in first trimester	2307	70.9	68.2	73.7	2048	85.0	82.9	87.0	<.0001

Note: Resp. – Number of respondents.
Wtd. % - Weighted proportion.
CI – Confidence intervals.
PNC – prenatal care.
Presented p-value is for chi square test for independence between race/ethnicity and study variables.

Table 1 (continued).

Study variables	Non-Hispanic Blacks				Non-Hispanic Whites				P-value
	Resp.	Wtd. %	95% CI for %		Resp.	Wtd. %	95% CI for %		
Maternal BMI categories									<.0001
Obese	926	31.0	28.0	34.0	495	21.5	19.2	23.8	
Overweight	528	17.8	15.3	20.3	300	11.2	9.5	13.0	
Underweight	341	9.7	7.8	11.5	360	13.2	11.3	15.1	
Normal weight	1305	41.5	38.4	44.7	1229	54.1	51.3	56.9	
Alcohol consumption									<.0001
Heavy/binge	195	5.8	4.5	7.1	374	16.6	14.5	18.7	
Low-to-moderate	272	9.0	7.2	10.8	306	13.6	11.7	15.5	
Not a drinker	2747	85.2	83.0	87.4	1717	69.8	67.2	72.4	
Smoking	346	10.1	8.3	11.8	725	27.5	24.9	30.0	<.0001
High blood pressure	656	14.1	12.1	16.1	479	14.1	12.2	16.0	<.0001
Diabetes before pregnancy	119	3.1	1.8	4.3	48	2.0	1.2	2.8	0.2841
Diabetes during pregnancy	276	6.9	5.5	8.4	211	8.0	6.5	9.5	.0561
Urinary tract infection	755	22.0	19.5	24.6	525	20.7	18.3	23.0	0.034
Severe nausea, vomiting, or dehydration	1146	33.2	30.3	36.2	737	28.8	26.3	31.3	.0512
Blood transfusion	69	1.4	0.6	2.2	37	0.7	0.3	1.1	0.3257
Car accident	103	3.1	2.0	4.2	52	2.0	1.2	2.8	0.0028
Needed help for depression during pregnancy	282	8.3	6.5	10.0	289	11.8	10.0	13.7	<.0001
Physically abused	308	8.2	6.7	9.7	152	5.1	3.9	6.4	0.0041
Child has a birth defect	50	1.1	0.7	1.4	48	0.8	0.4	1.3	0.6579
Child is a boy	1631	52.2	49.1	55.3	1202	50.4	47.6	53.1	0.0678
Hospitalization or bed rest	1626	37.5	34.6	40.4	1154	33.9	31.3	36.5	<.0001
High risk pregnancy (excluding early labor)	1959	54.2	51.1	57.3	1358	50.2	47.5	53.0	0.1081

Note: Resp. – Number of respondents.
Wtd. % - Weighted proportion.
CI – Confidence intervals.
PNC – prenatal care.
Presented p-value is for chi square test for independence between race/ethnicity and study variables.

Table 2. Distribution of stressful life events. Georgia PRAMS, 2004-2008.

Stressful events in the 12 month before delivery		Resp.	% of NHB	% of NHW	P-value
Moved to a new address		2172	32.4	32.9	0.9241
Argued with husband or partner more than usual		1874	30.6	20.9	<.0001
Had a lot of bills she couldn't pay		1560	25.4	19.5	0.003
A close family member was very sick and had to go into the hospital		1478	22.1	24.3	<.0001
Someone close to her died		1189	17.9	16.9	0.0015
Husband or partner lost his job		812	12.3	10.5	.0514
Lost job even though wanted to go on working		760	12.8	7.2	<.0001
Someone close to her had a bad problem with drinking or drugs		755	11.2	13.2	<.0001
Got separated or divorced from her husband or partner		663	12.4	6.5	<.0001
Husband or partner didn't want this pregnancy		608	10.7	6.6	0.0006
Husband/partner or herself went to jail		400	9.7	3.9	<.0001
Was in a physical fight		354	7.0	2.7	<.0001
Was homeless		218	3.3	1.2	<.0001
Number of stressful life events	1-2	1122	34.7	38.8	0.0006
	3-5	869	25.9	22.3	
	6+	271	8.2	4.3	
	None	865	31.2	34.6	

Note: Resp. – Number of respondents. NHB – non-Hispanic Blacks. NHW – non-Hispanic Whites.
% - Weighted proportions of respondents who answered 'yes' to questions about various stressful events in two study subpopulations.
About 4% of respondents didn't provide answers regarding stressful events.
P-value indicates significance of chi square test for independence between race/ethnicity and reported stressful events.

Table 3. Distribution of adverse birth outcomes. Georgia PRAMS, 2004-2008.

Birth outcomes	Non-Hispanic Blacks				Non-Hispanic Whites				P-value
	Resp.	Wtd. %	95% CI for %		Resp.	Wtd. %	95% CI for %		
Preterm births	1222	12.9	11.2	14.5	794	9.1	7.7	10.4	<.0001
Low birth weight	1658	12.3	11.5	13.1	1046	5.6	5.2	5.9	<.0001

Note: Resp. – Number of respondents.
Wtd. % - Weighted proportion.
CI – Confidence intervals.
Presented p-value is for chi square test for independence between race/ethnicity and study variables.

Table 4. Association of stressful events and preterm births. Georgia PRAMS, 2004-2008.

Stressful events	Non-Hispanic Blacks		Non-Hispanic Whites	
	Crude OR	95% CI for OR	Crude OR	95% CI for OR
Argued with husband or partner more than usual	1.14	0.85 - 1.51	1.51	1.03 - 2.22
Had a lot of bills she couldn't pay	1.07	0.79 - 1.46	1.51	1.02 - 2.23
Someone close to her died	1.41	0.96 - 2.06	1.02	0.65 - 1.61
Someone close to her had a bad problem with drinking or drugs	1.19	0.75 - 1.90	1.51	0.96 - 2.37
Got separated or divorced from her husband or partner	1.02	0.73 - 1.42	2.00	1.11 - 3.61
A close family member was very sick and had to go into the hospital	0.76	0.58 - 1.00	0.95	0.66 - 1.38
Was in a physical fight	1.53	0.86 - 2.73	1.15	0.50 - 2.65
Was homeless	0.85	0.46 - 1.57	0.65	0.31 - 1.37
Husband/partner or herself went to jail	1.38	0.75 - 2.54	1.22	0.56 - 2.67
Husband or partner lost his job	0.92	0.66 - 1.29	1.29	0.81 - 2.05
Moved to a new address	0.85	0.64 - 1.13	0.93	0.65 - 1.33
Husband or partner didn't want this pregnancy	1.10	0.77 - 1.57	1.45	0.82 - 2.57
Lost job even though wanted to go on working	1.03	0.74 - 1.44	1.32	0.70 - 2.48

Note: OR - odds ratio; CI - confidence interval.
Wald chi square p-values were >.05 for all bivariate logistic regressions.

Table 5. Association of stressful life events and low birth weight births. Georgia PRAMS, 2004-2008.

	Non-Hispanic Blacks			Non-Hispanic Whites		
Stressful events	Crude OR	95% CI for OR		Crude OR	95% CI for OR	
Argued with husband or partner more than usual	1.17	0.97 -	1.42	1.75**	1.39 -	2.22
Had a lot of bills she couldn't pay	1.00	0.81 -	1.24	1.66**	1.31 -	2.11
Someone close to her died	1.19	0.95 -	1.49	1.08	0.84 -	1.38
Someone close to her had a bad problem with drinking or drugs	0.98	0.73 -	1.33	1.47*	1.10 -	1.95
Got separated or divorced from her husband or partner	1.18	0.88 -	1.56	2.04**	1.40 -	2.97
A close family member was very sick and had to go into the hospital	1.03	0.83 -	1.28	1.19	0.95 -	1.50
Was in a physical fight	1.07	0.75 -	1.52	1.78	0.92 -	3.43
Was homeless	1.02	0.60 -	1.72	3.08	1.29 -	7.40
Husband/partner or herself went to jail	0.69*	0.49 -	0.98	1.82*	1.08 -	3.06
Husband or partner lost his job	1.00	0.77 -	1.32	1.63**	1.21 -	2.20
Moved to a new address	0.86	0.70 -	1.05	1.48**	1.21 -	1.81
Husband or partner didn't want this pregnancy	1.00	0.74 -	1.35	1.71**	1.20 -	2.44
Lost job even though wanted to go on working	1.16	0.88 -	1.53	1.63**	1.16 -	2.29

Note: OR - odds ratio; CI - confidence interval.
Significance of Wald chi-square for the model fit is indicated as shown:
* - p-value <.05
** - p-value <.01
*** - p-value <.0001

Table 6. Bivariate logistic regression for preterm births. Georgia PRAMS, 2004-2008.

	Non-Hispanic Blacks			Non-Hispanic Whites		
Study variables	Crude OR	95% CI for OR		Crude OR	95% CI for OR	
Maternal age categories						
<19	2.08*	1.21 -	3.58	1.02	0.50 -	2.06
35+	1.02	0.72 -	1.46	1.05	0.69 -	1.59
19-34						
Annual family income						
< $10,000	1.11	0.64 -	1.93	2.12**	1.28 -	3.52
$10,000 - $24,999	0.58**	0.34 -	0.98	1.26	0.79 -	2.00
$25,000 - $49,999	0.99	0.56 -	1.76	0.86*	0.56 -	1.34
$50,000 or more						
Not married	1.31	0.97 -	1.78	1.63*	1.12 -	2.37
Education						
<12 years	0.79	0.43 -	1.46	2.96**	1.43 -	6.15
12 years	0.93	0.57 -	1.52	1.27	0.86 -	1.89
>12 years						
Less than 6 months since previous pregnancy	2.03*	1.12 -	3.66	2.07*	1.07 -	3.99
Alcohol consumption						
Heavy/binge	0.81	0.52 -	1.28	0.78	0.48 -	1.26
Low-to-moderate	0.59*	0.39 -	0.87	0.77	0.48 -	1.26
Not a drinker						
High blood pressure	2.12***	1.55 -	2.90	1.92**	1.33 -	2.78
Diabetes before pregnancy	1.81*	0.98 -	3.33	1.74	0.61 -	5.00
Diabetes during pregnancy	1.76**	1.19 -	2.60	2.21**	1.31 -	3.71
Urinary tract infection	1.25	0.88 -	1.78	1.24	0.83 -	1.85
Severe nausea, vomiting, or dehydration	1.20	0.89 -	1.62	1.47*	1.03 -	2.09
Blood transfusion	7.20**	2.16 -	23.94	6.97**	2.26 -	21.47
Car accident	1.43	0.76 -	2.69	1.37	0.55 -	3.47
Smoking	0.86	0.61 -	1.21	1.49*	1.05 -	2.13
Child has a birth defect	1.45	0.73 -	2.89	3.38**	1.40 -	8.17
Child is a boy	1.04	0.77 -	1.40	1.45*	1.04 -	2.02

Note: OR - odds ratio; CI - confidence interval.
Significance of Wald chi-square for the model fit is indicated as shown:
* - p-value <.05
** - p-value <.01
*** - p-value <.0001
Italic font indicates reference categories.

Table 7. Bivariate logistic regression for low birth weight. Georgia PRAMS, 2004-2008.

		Non-Hispanic Blacks			Non-Hispanic Whites		
Study variables		Crude OR	95% CI for OR		Crude OR	95% CI for OR	
Annual family income	< $10,000	1.52*	1.11 -	2.07	2.68***	1.97 -	3.66
	$10,000 - $24,999	1.17	0.85 -	1.63	1.83	1.37 -	2.45
	$25,000 - $49,999	1.42	0.98 -	2.04	1.52	1.16 -	2.00
	$50,000 or more						
No health insurance before pregnancy		1.35**	1.12 -	1.63	1.80***	1.48 -	2.20
Enrolled in Medicaid		1.24	1.00 -	1.54	1.92***	1.57 -	2.33
Enrolled in WIC		0.97	0.79 -	1.20	1.76***	1.44 -	2.14
Not married		1.33**	1.10 -	1.62	1.62***	1.30 -	2.01
Education	<12 years	1.39*	1.06 -	1.82	2.11***	1.59 -	2.80
	12 years	1.13	0.92 -	1.39	1.40	1.12 -	1.75
	>12 years						
Pregnancy unintended		1.06	0.87 -	1.29	1.46**	1.20 -	1.78
Less than 6 months since previous pregnancy		1.42	0.96 -	2.10	1.76**	1.17 -	2.66
Parity	No previous live births	1.44**	1.14 -	1.82	1.15*	0.88 -	1.49
	1 previous live birth	1.06	0.82 -	1.37	0.82*	0.62 -	1.09
	2+ previous live births						
PNC in first trimester		0.80*	0.64 -	0.99	0.73*	0.55 -	0.97
Maternal BMI categories	Obese	0.83**	0.66 -	1.04	0.96	0.75 -	1.23
	Overweight	1.00	0.75 -	1.32	1.29	0.95 -	1.74
	Underweight	1.35*	0.97 -	1.87	1.58**	1.19 -	2.09
	Normal weight						
Alcohol consumption	Heavy/binge	0.82	0.56 -	1.20	0.80	0.60 -	1.07
	Low-to-moderate	0.79	0.56 -	1.11	0.73	0.55 -	0.98
	Not a drinker						
High blood pressure		2.38***	1.86 -	3.05	2.56***	2.00 -	3.26
Diabetes before pregnancy		2.26**	1.25 -	4.10	1.38	0.71 -	2.68
Diabetes during pregnancy		1.64**	1.17 -	2.31	1.14	0.82 -	1.59
Severe nausea, vomiting, or dehydration		1.31**	1.07 -	1.59	1.40**	1.13 -	1.72
Blood transfusion		3.53**	1.40 -	8.91	4.29**	1.89 -	9.72
Smoking		1.34	0.99 -	1.80	1.67***	1.36 -	2.06
Child has a birth defect		2.17*	1.13 -	4.19	4.92***	2.43 -	9.97
Child is a boy		0.78*	0.65 -	0.94	0.89	0.73 -	1.08

Note: OR - odds ratio; CI - confidence interval. PNC – prenatal care.
Significance of Wald chi-square for the model fit is indicated as shown:
* - p-value <.05
** - p-value <.01
*** - p-value <.0001
Italic font indicates reference categories.

Table 8. Results of multivariate logistic regression analysis for preterm births.

Georgia PRAMS, 2004-2008.

	Non-Hispanic Blacks			Non-Hispanic Whites		
Independent variables	Adj. OR	95% CI for OR		Adj. OR	95% CI for OR	
Got separated or divorced from her husband or partner	**1.99****	**1.19 -**	**3.34**	1.57	0.57 -	4.31
Maternal age						
<19	**4.54****	**1.57 -**	**13.14**	0.21	0.02 -	1.93
35+	0.89*	0.48 -	1.65	1.38	0.73 -	2.64
19-34						
Annual family income						
< $10,000	0.76	0.25 -	2.35	0.98	0.34 -	2.85
$10,000 - $24,999	0.44*	0.18 -	1.06	1.48	0.69 -	3.18
$25,000 - $49,999	0.65	0.28 -	1.53	1.33	0.65 -	2.73
$50,000 or more						
Education						
<12 years	0.67	0.26 -	1.76	**2.93***	**1.32 -**	**6.54**
12 years	1.01	0.50 -	2.03	1.65	0.87 -	3.15
>12 years						
Less than 6 months since previous pregnancy	1.29	0.77 -	2.18	1.86	0.85 -	4.09
Alcohol consumption						
Heavy/binge	1.05	0.50 -	2.19	0.88	0.36 -	2.14
Low-to-moderate	**0.4****	**0.21 -**	**0.76**	1.90	0.89 -	4.03
Not a drinker						
Diabetes during pregnancy	**1.88***	**1.04 -**	**3.41**	1.85	0.87 -	3.92
High blood pressure	**1.99****	**1.26 -**	**3.16**	**2.22***	**1.21 -**	**4.08**
Blood transfusion	**9.68*****	**3.49 -**	**26.88**	**5.31***	**1.33 -**	**21.22**
Child has a birth defect	2.49	0.73 -	8.55	**4.14***	**1.19 -**	**14.35**

Note: Adj. OR - adjusted odds ratio; CI - confidence interval.
Multivariate logistic regression for predicting preterm births. Reference categories if independent variables are indicated by *italic* font. **Bold** font indicates significant 95% CI for OR. Significance of predictors is indicated by asterisks: * p-value <.05, ** p-value <.01, *** p-value <.0001.

Table 9. Multivariate logistic regression for low birth weight. Georgia PRAMS, 2004-2008.

	Non-Hispanic Blacks			Non-Hispanic Whites		
Independent variables	Adj. OR	95% CI for OR		Adj. OR	95% CI for OR	
Argued with husband or partner more than usual	1.26	0.88 -	1.81	1.46	0.95 -	2.26
Someone close to her had a bad problem with drinking or drugs	**0.48***	**0.26 -**	**0.90**	0.94	0.51 -	1.74
Got separated or divorced from her husband or partner	**1.81***	**1.09 -**	**3.01**	1.71	0.86 -	3.42
Was homeless	1.03	0.44 -	2.38	3.15	0.67 -	14.85
Husband/partner or herself went to jail	**0.44***	**0.22 -**	**0.85**	0.82	0.31 -	2.16
Husband or partner lost his job	1.43	0.91 -	2.25	1.20	0.71 -	2.03
Moved to a new address	0.90	0.61 -	1.31	1.38	0.92 -	2.07
Lost job even though wanted to go on working	1.34	0.86 -	2.10	0.77	0.38 -	1.57
Annual family income						
< $10,000	0.98	0.54 -	1.76	1.89	0.84 -	4.22
$10,000 - $24,999	0.91	0.51 -	1.63	**2.01**	**1.11 -**	**3.65**
$25,000 - $49,999	1.17	0.63 -	2.17	**2.34**	**1.41 -**	**3.88**
$50,000 or more						
No health insurance before pregnancy	1.33	0.90 -	1.97	1.20	0.76 -	1.91
Less than 6 months since previous pregnancy	**1.81***	**1.08 -**	**3.02**	**2.23****	**1.30 -**	**3.82**
Maternal BMI categories						
Obese	**0.62****	**0.41 -**	**0.91**	0.62**	0.39 -	1.00
Overweight	1.23	0.76 -	1.97	0.81	0.43 -	1.55
Underweight	1.41	0.78 -	2.55	**2.53*****	**1.47 -**	**4.34**
Normal weight						
Alcohol consumption						
Heavy/binge	0.73	0.40 -	1.35	**0.48**	**0.26 -**	**0.91**
Low-to-moderate	0.61	0.33 -	1.12	0.75	0.40 -	1.40
Not a drinker						
Smoking	1.45	0.88 -	2.39	1.56	0.98 -	2.46
High blood pressure	**2.79*****	**1.86 -**	**4.19**	**4.11*****	**2.49 -**	**6.77**
Diabetes before pregnancy	**2.55***	**1.09 -**	**5.94**	0.66	0.14 -	3.10
Diabetes during pregnancy	1.45	0.81 -	2.58	0.73	0.37 -	1.46
Severe nausea, vomiting, or dehydration	1.30	0.91 -	1.87	1.25	0.84 -	1.87
Blood transfusion	**9.21****	**2.77 -**	**30.63**	2.52	0.71 -	8.99
Child has a birth defect	2.17	0.81 -	5.81	2.96	0.98 -	8.92
Child is a boy	**0.66***	**0.48 -**	**0.92**	1.27	0.88 -	1.84

Note: Adj. OR - adjusted odds ratio; CI - confidence interval.

Multivariate logistic regression for predicting low birth weight births. Reference categories if independent variables are indicated by *italic* font. **Bold** font indicates significant 95% CI for OR. Significance of predictors is indicated by asterisks: * p<.05, ** p <.01, *** p <.0001.

Table 10. Summary table of variables associated with preterm and low birth weight births. Georgia PRAMS, 2004-2008.

	Preterm births	Low birth weight
Non-Hispanic Blacks	***Risk factors:***	***Risk factors:***
	Got separated or divorced	Got separated or divorced
	Maternal age <19	Inter-pregnancy interval less than 6 months
	Diabetes during pregnancy	Diabetes during pregnancy
	High blood pressure during pregnancy	High blood pressure during pregnancy
	Blood transfusion	Blood transfusion
	Protective factors:	***Protective factors:***
	Low-to-moderate alcohol consumption	Someone close had a bad problem with drinking or drugs
		Husband/partner or herself went to jail
		BMI: obese
		Child's male gender
Non-Hispanic Whites	***Risk factors:***	***Risk factors:***
	Education less than 12 years	Annual family income $10,000-$49,999
	High blood pressure during pregnancy	Inter-pregnancy interval less than 6 months
	Blood transfusion	BMI: underweight
	Child's birth defect	High blood pressure during pregnancy
	Protective factors:	***Protective factors:***
	None	Heavy/binge alcohol consumption

Note: Reference for maternal age was 20-35 years; for alcohol consumption – not a drinker; for education – more than 12 years; for BMI – normal weight; and for annual family income - $50,000 or more. Refer to tables 8 and 9 for adjusted ORs and lists of all variables included in regression models.

Chapter V

Discussion and Conclusion

The purpose of the study was to analyze stressful life events and their possible association with preterm births, low birth weight and racial disparities in birth outcomes. Georgia PRAMS data for years 2004-2008 was used to obtain information on demographic, socio-economic, behavioral, and health indicators for the sample of women 3,269 non-Hispanic Black and 2,430 non-Hispanic White women who had recently delivered a live singleton infant. Preterm birth (at less than 37 full gestational weeks) and low birth weight (less than 2,500 g at birth) were the outcomes of interest. Independent variables were 13 stressful life events reported in the year before delivery. A range of other factors known to be associated with the outcomes were included as independent variables in bivariate logistic regression and as control variables in multivariate logistic regression. These factors were generally associated with race. For example, Blacks had more very young mothers and more characteristics related to a low SES: lower income, less health insurance before pregnancy, more WIC and Medicaid enrollment, lower education, etc. As for obstetric history, approximately equal proportions of respondents had a short interval since previous pregnancy, or had one previous live birth, whereas Black race and non-Hispanic ethnicity was associated with more previous adverse birth outcomes, as well as more previous live births and fewer women initiating prenatal care in the first trimester. Further description of the sample includes alcohol and tobacco consumption, which were lower and lighter in Blacks. Berg, Wilcox et al. reported Black women being disadvantaged on many risk factors but drinking alcohol and smoking less

than Whites (2001). Self-reported drinking and smoking was found to be generally truthful in the National Social Life, Health, and Aging Project, that had similarly structured self-report questions backed by saliva test for cotinine (tobacco metabolite) and an alcohol screening instrument. According to the same study authors, average alcohol consumption should interpreted cautiously as a weekly consumption will be the same for a person having one drink every day and a person having seven drinks in one day of a week (Drum, Shiovitz-Ezra, Gaumer, & Lindau, 2009).

Maternal health in Blacks had more risk factors, despite less alcohol and tobacco use, such as excess weight, urinary tract infections, being injured in a car accident, being physically abused and needing bed rest or hospitalization for their conditions. The study groups had been equally affected by high blood pressure, diabetes, severe nausea or dehydration, blood transfusion. Also proportion of women who had reported at least one high risk medical condition, besides signs of early labor, was similar in Blacks and Whites. Blood transfusion was a rare event, but had a strong association with the outcomes. There were two concerns about keeping the variable in the multivariate model. First, it reflected high risk, but not the nature of the risk, similarly to the previous birth outcomes. Secondly, blood transfusions in pregnant women are so extremely rare, that I couldn’t find any reports of such in scientific literature from the US. Most certainly, women who reported having blood transfusion referred to a postpartum transfusion, which is more commonly performed, because the survey was conducted 2 to 6 months after delivery and there might have been recall bias. Despite the concerns, I decided to keep it because indications for blood transfusion are narrow enough to provide some

insights of the pathways, nutritional (iron and vitamin deficiency in a diet) and infectious (helminthic, bacterial and viral, i.e. HIV). (Goonewardene, Shehata, & Hamad, 2012).

Finally, infants of Black and White respondents were not significantly different in terms of gender and birth defects distribution. Birth defects information came from birth certificate and is likely to be underreported. Prevalence of birth defects in this study population was about 1%, whereas for Georgia it was reported as about 3% (Boulet, Shin, Kirby, Goodman, & Correa, 2011).

In regards to answering to the first research question about ***estimate of stress that is available from PRAMS data***, there are thirteen stressful life events, which respondents report having in the year before delivery. These events provide coverage for a range of financial, emotional, traumatic, environmental, and partner-related stressful exposures. Other variables were also available, that could be approximation of stress: low income, unintended pregnancy, short inter-pregnancy interval, marital status, and physical abuse (Dunkel Schetter, 2011). These variables had weak correlation with each other and the stressful events. Only moderate correlation was noted between not being married and having an unintended pregnancy ($R=0.35$, $p<.0001$). Independently, low income, being not married, having less than 6 months between the last pregnancies, and unintended pregnancy were associated with increased odds for adverse birth outcomes. When controlled for in multivariate logistic regression, they added to the overall significance and the fit of the model, though only short inter-pregnancy interval still increased odds of PTB and LBW. Having next pregnancy too soon is not only adding to the stress level of a mother who has to take care of an infant on top of regular and pregnancy-related responsibilities and anxieties. Mostly, impact of short inter-pregnancy interval is related

to the depletion of maternal resources during earlier pregnancy and breastfeeding that negatively affects growth of the following child (C. J. Hogue, Menon, Dunlop, & Kramer, 2011). Other factors, like low income and being a single parent, obviously add to the level of stress, however they are also involved in different pathways leading to adverse birth outcomes (M. R. Kramer, Hogue, Dunlop, & Menon, 2011; Nkansah-Amankra, Luchok, Hussey, Watkins, & Liu, 2010; N. S. Whitehead, et al., 2003).

Is there racial/ethnic disparity in stress estimates available from PRAMS? Analysis of distribution of stressful events in Georgia PRAMS data demonstrated existing disparity between Blacks and Whites. Blacks had generally higher prevalence of events, than Whites. Frequency of some events was as much as two times higher in Blacks compared to Whites: homelessness (3.3% vs. 1.2%), having had physical fight (7% vs. 2.7%), going to jail (9.7% vs. 3.9%), and divorce or separation (12.4% vs. 6.5%). Ranking of individual events by prevalence was comparable in two groups (moving being the most frequent, and homelessness – the least frequent event). These findings match another analysis of stressful events distribution in PRAMS respondents that was conducted for multistate, multiyear data (N. S. Whitehead, et al., 2003).

Looking into the nature of stressful events, some authors have grouped them as financial (woman loosing job, partner loosing job, moving to a new address, and unpaid bills); emotional (having serious sickness in the family and having a close person to die); partner-related (partner didn't want pregnancy, arguing more than usual, and getting divorces/separated); and traumatic (woman or partner going to jail, woman or partner having serious drinking or drug problem, being homeless, and being involved in a physical fight) (Ahluwalia, et al., 2001; Nkansah-Amankra, et al., 2010). At the same

time, a score of a number of reported events is also utilized (Ahluwalia, et al., 2001; D'Angelo et al., 2007). Such approaches are convenient as they allow for fewer variables to manipulate, however it might be questionable as an accurate estimate of the stress level. The four categories are not mutually exclusive. One could argue that getting divorced is as much emotional as it is partner-related, and being homeless is as financial as it is emotional and traumatic. Stressful events reported in PRAMS are different in their intensity, duration, and possible negative health consequences (moving to a new address vs. being involved in a physical fight, for example). In fact, some of these stressful events may have a positive nature, for example, moving to a bigger house in anticipation of the baby. This adds to the complexity of measuring and interpreting stress.

Keeping abovementioned in mind, by observation of reported stressful events in the study groups it appears that Blacks are more likely to be experience financial kind of stress, such as: having a lot of unpaid bills was, losing a job, getting divorced or separated (losing second income in the household), being homeless (most likely due to financial crisis), or having been sentenced to jail or having a partner sentenced to jail (losing income). So, distribution of stressful events in Black and White groups may reflect existing socio-economic disparity. Indeed, controlling for income, there was less association between race and stressful events. In low income category (less than $10,000) there was significant association between race and such events as unpaid bills, serious illness in a family, death of someone close, serious drinking or drug problems, and being homeless ($p<.05$). In higher income stratum ($50,000 or more) significant association with race was only for getting divorced or separated ($p<.05$). At the same time, controlling for race/ethnicity, there was significant association between prevalence of

stressful events and income, meaning that within a race/ethnicity group, there was significant difference in proportion of women who had experienced a stressful event by income strata ($p<.01$). In other words, income had more influence on prevalence of stressful events, than race.

Does stress during pregnancy predict PTB and LBW? Not every stressful event was associated with increased odds of PTB and LBW individually. Whites were more likely to be affected by the events than Blacks, and risk of low birth weight was associated with more stressful events, than risk of preterm birth. It appears that when unadjusted, getting divorced and being homeless were the strongest risk factors for the adverse birth outcomes in Whites. All remaining event, with the exception of sickness and death in the family, and a physical fight, significantly increased odds ratio of LBW in the White group. The three exceptions were also associated with increased OR, however the 95% confidence intervals for the OR were not significant. In Black group, only one association was statistically significant: a respondent or her partner going jail was protective against low birth weight (OR=0.69, 95% CI for OR 0.49-0.98, $p<.5$). These findings might be indicating that pathways of experiencing stressful life events have more influence on the intrauterine fetal growth than on the onset of labor. On the other hand, this might be due to misclassification problem, as gestational age is often miscalculated, whereas birth weight is determined more accurately (M. S. Kramer, 2003).

Does stress during pregnancy predict PTB and LBW when controlling for known effect modifiers and confounders? When controlled for demographic, SES, obstetric and medical history and infant's gender and birth defects, none of the adjusted stressful events remained significant predictors of PTB and LBW for Whites. Other researchers

have found similar relationship. Also in the PRAMS data there was a strong association between some of stressful events was weakened by controlling for maternal race, SES, and tobacco use (Nedra S. Whitehead, Hill, Brogan, & Blackmore-Prince, 2002). In Black study group, in contrast, controlling for possible effect modifiers and confounders strengthened the association of the events and birth outcomes. Getting divorced was a risk factor for both PTB and LBW in Blacks. Having a serious problem with drinking or drugs and going to jail were protective. I speculated that going to jail may become protective to a certain population of very low SES women who either get better prenatal care while being incarcerated or are relieved from negative influence from their husbands/partners (i.e. abuse, stress, second-hand smoking) if their husband/partners are incarcerated. I found to association of jail and income, age, or education of respondents. Neither did I find explanation of this effect or effect of drinking/drugs problem in scientific literature. This could be further researched in future studies.

Protective effect of alcohol consumption on PTB in Black group was dependent on other variables in the model. For example, removing diabetes from the model has led to insignificant confidence intervals for adjusted OR of alcohol consumption. Some variations of the independent variables resulted in protective effect of heavy/binge drinking. On the other hand, alcohol was still protective in bivariate regression and 2-by-2 tables stratified by race/ethnicity, income, and maternal age. Also, two effects of alcohol consumption (heavy/binge and low-to-moderate) were strongly positively correlated ($R=0.74$, $p<.05$). Taking into account results by Drum et al. (2009), I assumed that this effect was due to the way the questions about alcohol consumption were asked in PRAMS. Whitehead and Lipscomb (2003) researched multiyear multistate PRAMS data

and found binge drinking before pregnancy to be protective against small for gestational age birth outcome. They explained the finding by vascular effects of alcohol and possible dietary differences of drinkers and nondrinkers. More research is needed in this area of alcohol consumption and pregnancy processes.

I also noticed that Blacks and Whites differed in what kinds of risk factors were significant in multivariate analysis. All risk factor significant in Blacks were related to maternal health (BMI, blood pressure, blood transfusion, diabetes, and short inter-pregnancy interval). Whites were sensitive to both maternal health factors and SES: education, income. Some other authors found that traditional risk factors were not significant in predicting of LBW in Black women. It may be explained by very high prevalence of these factors in Blacks or by contribution of different factors, not examined by the researchers (Berg, et al., 2001; Dailey, 2009).

Chen, Grobman, Gollan and Borders (2011) in their review of psychological stress scales in preterm births research list works that found stressful life events to be risk factors for LBW and PTB, and works that found no such association. Apparently, timing of the event during pregnancy plays role, with events happening in the last six months having no association with LBW. Also, White women were more likely to have stressful events associated with PTB and LBW, and money-related events were more significant. Overall conclusion of the review was that association of self-reported stress and birth outcomes was inconsistent (M. J. Chen, et al., 2011).

Is there racial/ethnic disparity in the predictive value of stress? Non-Hispanic Whites and Blacks had different associations of stressful events and adverse birth outcomes.

Stresses contributed to adverse pregnancy outcomes in Whites only in unadjusted regression. When adjusted for socio-economic and biological factors, stressful events lost their significance in Whites. In Blacks, some stressful events were significant predictors of PTB and LBW only when controlling for SES and health indicators. I suggest that Whites were sensitive to stressful events less than to socio-economic and medical risks. Blacks are more affected by stresses than Whites given the same levels of other risks.

Strengths and limitations

Strength of this study was using the PRAMS database itself, with its standardized methodology allowing for both inter-states comparisons and for single-state analysis and its representativeness of the general population. Robust quality control and standard protocols ensure high level of completeness of the data, internal and external validity, and minimal bias. Oversampling of minority populations and low birth weight births ensures an adequate sample size and possibility of various stratifications. Last, but not least, PRAMS and birth certificates provide wealth of information on various risk factors, possible confounders and effect modifiers.

Despite high quality of the data, the study had its limitations. For example, in 2004 two of the strata had response rate below 70%, which may have introduced bias (Hoban, et al., 2007). Cross-sectional nature of the survey only reveals associations but not causality between independent variables and outcomes, and don't provide temporal relationship between events. PRAMS questionnaires provide only self-reported data that can be validated partially by birth certificates data, but is still subject to information bias. Sensitive events, i.e. abuse, alcohol, or drug issues, are likely to be underreported.

Another limitation of the study is that PRAMS only collects information on live-born infants and their mothers. So we don't have information of infant who died during labor or just before delivery. Given that these infants are likely to be affected by PTB and/or LBW we would like to include them in the study (Mathews & MacDorman, 2008).

HIV infection is an important risk factor for both PTB and LBW (Jao, et al., 2012; Salihu et al., 2012), however PRAMS only collects information about awareness of HIV and having been tested for HIV, but not the HIV status of respondents. Lack of this essential information may have affected results of the study.

Other possible effect modifiers and confounders could not be accounted for: neighborhoods, sexually transmitted infections, bacterial vaginosis, environmental hazards, induced or spontaneous nature of PTB, etc. may have affected findings of the study.

Finally and importantly, stress has such a large natural variation that making estimates of stress is extremely difficult. In a single person stress level is ever-changing depending on physical condition, timing of stressful event, coping mechanisms etc. Challenges of estimating stress levels are exhaustively discussed by various reviewers (Alderdice, et al., 2012; M. J. Chen, et al., 2011; C. J. R. Hogue & Bremner, 2005b; Jackson, et al., 2012).

Information provided by life events questions is very limited: only presence or absence of the event without references to its timing in pregnancy (before pregnancy, at the beginning or at the end of it), perceived severity of stress, or coping mechanisms (social support, substance use, etc.). These additional details dramatically affect degree and

nature of influence of stress on a mother and her embryo (Gennaro, 2003; Glynn, 2008; Hobel, et al., 2008).

Public health implications

Further research is needed to illuminate relationships between stress and pregnancy outcomes, though there is definitely an association. From the practical point of view, it appears that including information of possible stress effects on pregnancy into communication between health professionals and women, as well as teaching women to recognize stress and employ effective coping mechanisms could reduce adverse outcomes. Also, improving health of women before conception and during pregnancy has potential to contribute to reduction of adverse birth outcomes.

Conclusion

Prenatal stress attracts increasing research interest as possible explanation of racial and ethnic disparities in adverse birth outcomes. Lack of sound theoretical framework and challenges in accurate estimation of stress lead to inconsistent and inconclusive results so far. This study serves as additional evidence for the need of an accurate and comprehensive stress measurement tool and for further research. There is evidence for association of stress and low birth weight as well as preterm births; however socio-economic factors and mother's health status were more significant in predicting birth outcome. While continuing research of stress and its pathways to fetal development and labor activities, improving women's health and SES are likely to increase favorable pregnancy outcomes and reduce racial disparities.

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