DEFINING PRECONCEPTION WELLNESS AND EXAMINING ITS ASSOCIATION WITH PRETERM BIRTH AND ITS CLINICAL SUBTYPES AMONG GEORGIA MOTHERS

by

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(Under the Direction of José F. Cordero)

ABSTRACT

Background: There is a growing consensus that preconception care, rather than prenatal care, throughout the life course is the ideal practice. Expecting the short period of prenatal care to reverse the impact of early life programming and cumulative allostatic load on a woman's reproductive health may be impractical. The purpose of this dissertation was to 1) examine the distribution of preconception wellness indicators, 2) to examine the association between preconception wellness and preterm birth overall, and 3) to examine the association between preconception wellness and preterm birth clinical subtypes. **Methods**: Data were collected during 2009-2013 in the Georgia Pregnancy Risk Assessment Monitoring System (PRAMS), a state specific population-based surveillance system that collects data on select maternal behaviors and experiences occurring before, during, and shortly after pregnancy. Nine preconception wellness indicators as defined by the Clinical Workgroup of the CDC Preconception Health and Healthcare Initiative were examined, including pregnancy intention, access to care, folic acid use, tobacco avoidance, depression screening/treatment, diabetes screening/treatment, healthy weight, absence of sexually transmitted infections, and teratogen avoidance. Preconception wellness indicators experienced per mom were summed and categorized as 1-3, 4-6, and 7-9 for analysis. Descriptive statistics, bivariate analyses, and logistic regression models assessed the experience of preconception wellness individually and cumulatively by PTB overall and by its clinical subtypes. **Results**: About 9% of mothers delivered an infant who was less than 37 weeks' gestation. Preconception wellness indicators experienced ranged from 7.7% (depression screening/treatment) to 96.9% (absence of sexually transmitted infection). As the number of cumulative PCW indicators increased, the odds of PTB decreased; however, this decreases in odds were not statistically significant. As the number of cumulative PCW indicators increased, the odds of SPTB decreased and the odds of MIPTB increased; however, these trends were not significantly different from moms who experienced 1 to 3 PCW indicators.

Conclusion: By applying the Clinical Workgroup's concept of preconception wellness to Georgia PRAMS, we provided a baseline for preconception wellness among Georgia moms. Given PRAMS' standardized methodology, this study can be replicated within other PRAMS sites to aid in the prioritization of preconception wellness in the United States.

INDEX WORDS: preconception wellness, preterm birth, PRAMS, maternal and infant health surveillance

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DEDICATION

Dad and Mom, this is for you.

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CHAPTER 1

INTRODUCTION

Statement of the Problem

A woman's health in the preconception period is linked to both pregnancy and lifelong health outcomes for herself and her children[1]. In recent years, there has been a growing focus on a life course perspective in prevention and health promotion emphasizing the importance of one's health prior to conception[2]. Preconception care refers to the process of identifying social, behavioral, environmental, and biomedical risks to a woman's fertility and pregnancy outcome and reducing these risks through education, counseling, and appropriate intervention before conception[3,4]. It is suggested that preconception care should be provided as an integral part of a woman's health care continuum throughout her life course rather than in a single visit shortly before a planned pregnancy[2,5].

As part of preventive care for all women of reproductive age, the American College of Obstetricians and Gynecologists, the Institute of Medicine, and the Centers for Disease Control and Prevention (CDC) recommend routine screening and risk-appropriate preconception care that encourages reproductive life planning –a process where providers support women in establishing reproductive goals and provide services based on those goals[1].

The Clinical Workgroup of the CDC Preconception Health and Health Care Initiative proposed nine measures that met consensus group criteria based on the ease of implementation and evidence to affect improvement (Table 1.1). The notion was that a composite of the nine PCW measures could be addressed through risk modification and ultimately improve women, fetal, and infant health outcomes. The workgroup's goal was to define the smallest number of metrics that would capture the greatest proportion of a woman's PCW[6].

Table 1.1. Description of Preconception Wellness (PCW) Measures as Defined by Clinical Workgroup of the CDC Preconception Health and Health Care Initiative

	Measure	Clinical Workgroup Description	Proposed Data Source	Relevant Georgia PRAMS Survey Question
PCW 1	Pregnancy intention	Reduction in unintended pregnancies, improvement in optimal birth spacing	PRAMS	"Thinking back to just before you got pregnant with your new baby, how did you feel about becoming pregnant?"
PCW 2	Access to care	Registered for prenatal care in first trimester	PRAMS	"How many weeks or months pregnant were you when you had your first visit for prenatal care?"
PCW 3	Folic acid use	Use of a daily multivitamin with folic acid for at least 3 months before conception	PRAMS	"During the month before you got pregnant with your new baby, how many times a week did you take a multivitamin, a prenatal vitamin, or folic acid vitamin?
PCW 4	Tobacco avoidance	Prepregnancy smoking cessation	PRAMS	"Have you smoked any cigarettes in the past 2 years?"
PCW 5	Depression screening/treatment	Evidence-based depression screening	PRAMS	"During the 12 months before you got pregnant with your new baby, did you visit a health care worker to be check or treated for depression or anxiety?"

PCW 6	Healthy weight	Healthy prepregnancy body mass index with preconception nutritional counseling	PRAMS	Just before you got pregnant with your new baby, how much did you weigh?
PCW 7	Absence of sexually transmitted infections (STI)	Absence of active STI at conception	BC	*Note: Only absence of STI during pregnancy or at delivery can be ascertained.*
PCW 8	Diabetes screening/treatment	For pregestational diabetes, optimal A_{1C}	PRAMS	"During the 12 months before you got pregnant with your new baby, did you visit a health care worker to be checked or treated for diabetes?"
PCW 9	Teratogen avoidance in chronic conditions	Avoidance of teratogenic medications for women at risk of pregnancy	PRAMS	"During the 12 months before you got pregnant with your new baby, were you regularly taking prescription medicines other than birth control?"

PRAMS: Pregnancy Risk Assessment Monitoring System; BC: Birth certificate

Study Purpose and Objective

The purpose of this research is to determine the extent to which the proposed quality metrics on preconception wellness predict preterm birth in Georgia women using state surveillance data. To date, this is the first study to discuss the feasibility of using a single surveillance system such as the Georgia Pregnancy Risk Assessment Monitoring System (PRAMS) to describe preconception wellness as defined by the Clinical Workgroup of the CDC Preconception Health and Health Care Initiative. Our objective was to identify modifiable factors and provide strategies to improve a woman's overall preconception wellness.

Study Aims

AIM 1: To examine the distribution of preconception wellness indicators as defined by the Clinical Workgroup of the National Preconception Health and Health Care Initiative.

- It was hypothesized that it was feasible to use Georgia PRAMS data to examine the distribution of preconception wellness indicators among Georgia mothers who recently had a live birth.

AIM 2: To examine the association between preconception wellness and preterm birth.

- It was hypothesized that there was a significant association between PCW and PTB where the more PCW indicators experienced, the lower a woman's odds of preterm birth.

AIM 3: To examine the association between preconception wellness and preterm birth clinical subtypes as previously defined (spontaneous vs. medically induced preterm birth).

- It was hypothesized that there was a significant association between PCW and PTB clinical subtypes (spontaneous and medically induced preterm birth) where the more PCW indicators experienced, the lower a woman's odds of either spontaneous or medically induced preterm birth.

The dataset utilized for this study was the Georgia Pregnancy Risk Assessment Monitoring System (PRAMS). Georgia PRAMS is a state population-based survey that supplements birth certificate data on women's attitudes, experiences, and behaviors before, during, and shortly after pregnancy[7].

Significance of Research

This research addressed the notion of preconception wellness among Georgia mothers. In 2011, the proportion of unintended pregnancies in Georgia was 54.8% and of those who were not trying to get pregnant, less than half (48.6%) were using birth control at conception[8]. Unintended pregnancies give less opportunity to intervene on preconception wellness. Although there has been progress in policy, consumer outreach and message development, public health programming, and clinician education on preconception wellness[9], there has been a lag in clinical implementation. Frayne and colleagues[6] believed the delay in implementation was attributable to a lack of consensus on quality measures of preconception care. This research provides additional evidence for the use of the established quality metrics described in Table 1.1. Additionally, these methods can be replicated in other PRAMS states to aid in the prioritization of preconception indicators.

Study Outline

Chapter 2 details relevant literature that provides an overview of preconception wellness, a thorough description of the epidemiology of preterm birth (outcome of interest), health disparities within preterm birth, and gaps in the literature. Chapter 3 describes the methods used to carry out this research, including data collection, data sources, and statistical analyses. Chapters 4, 5, and 6 are presented in manuscript format, including an introduction, methods, results, discussion, and references section, and detail each study aim individually. The final chapter provides an overall summary of significant findings, describes study strengths and limitations, and provides recommendations for future investigations.

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CHAPTER 2

LITERATURE REVIEW

Introduction

The following is an overview of the literature regarding the concept of preconception care (PCC) and wellness (PCW) with a specific focus on how PCW can aid in the aversion of preterm birth (PTB). The following sections include an overview and history of preconception care, a description of preconception health indicators, a discussion on the relationship between preconception health and PTB, and the epidemiology of PTB in the United States and in Georgia over the years. Finally, gaps in current literature and suggested direction of future research were presented.

Shift from Prenatal Care to Lifecourse Perspective

Prenatal care (PNC) refers to the health care that a woman receives during pregnancy consisting of a series of assessments and appropriate treatments for pregnant women[1]. This care contains three basic components defined as 1) early and continuing risk assessment, 2) health promotion, and 3) medical and psychosocial interventions and follow up[2]. Increasing the receipt of early and adequate PNC has been a major public health goal for decades. According to the Department of Health and Human Services' *Healthy People 2020*, the target goal for pregnant women receiving early and adequate PNC is 77.6% and was last at 70.5% in 2007[3]. Although PNC is thought to reduce risk for low infant birth weight and PTB, some argue that the first prenatal visit is too late to start caring for a pregnancy[4-7]. Due to the high proportion of women who have an unintended pregnancy[8], oftentimes exposure to potential teratogens may have already occurred by the first PNC visit, which is ideally by 10 weeks of pregnancy[9].

For over two decades, PNC has been a cornerstone to the nation's strategy for improving pregnancy outcomes; however, in recent years the effectiveness of this strategy has been called into question[10]. Increasing use of early and adequate prenatal care has not led to a significant decline in prematurity (one of the leading causes of infant mortality in the United States) nor has closing the access gap in PNC led to a significant reduction in racial/ethnic disparities in adverse birth outcomes[11]. Furthermore, expecting the short period of PNC to reverse the impact of early life programming and cumulative allostatic load on a woman's reproductive health may be impractical[12]. There is a growing consensus that the notion of preconception care throughout the life course of a woman is ideal practice. Preconception care may also be "too little too late" if it is provided in a single visit shortly before a planned pregnancy rather than as an integral part of a woman's health care continuum throughout her life course[13,14].

The purpose of preconception care is to identify and modify biomedical, behavioral, and social risks to a woman's health or pregnancy outcome through prevention and management strategies[4,15]. Caring for a pregnancy should happen well before conception and preconception care should occur every time any health care provider visits with a woman of reproductive age[4]. During the past decade, the slight decline in adverse birth outcomes despite improvements in PNC suggests that PNC alone is not sufficient to ensure positive pregnancy outcomes[10,16-18]. Preconception care provides an opportunity to optimize the health of a woman independent of whether she becomes pregnant[19]. Fine and Kotelchuck identified the lifecourse model, a conceptual framework that aids in the explanation of health and disease patterns, specifically health disparities, across populations and over time[14]. Three key concepts were identified to systemically shift our thinking about a person's health: 1) recognition of context and the "whole-person, whole-family, whole-community systems" approach, 2) longitudinal approach with greater emphasis on early (upstream) determinants of health, and 3) need for integration and developing integrated, multi-sector service systems that become lifelong "pipelines" for healthy development[14,20]. The notion is to change priorities and paradigms in the healthcare delivery system, such as delivery of preconception care.

History of Preconception Health

The notion of preconception health is not a novel one. Women have been counseled since the earliest recorded time to increase their level of wellness and avoid hazardous substances before pregnancy. Ancient Spartans ordered women "to exercise themselves with wrestling, running, throwing the quoit, and casting the dart, to the end that the fruit they conceived might, in strong and healthy bodies, take firmer root and find better growth, and withal that they, with this greater vigour, might be the more able to undergo the pains of child-bearing"[21]. In the Old Testament, "[t]he angel of the Lord appeared to [Samson's mother] and said, 'You are sterile and childless, but you are going to conceive and have a son. Now see to it that you drink no wine or other fermented drink and that you do not eat anything unclean...' "[22]. These texts discuss components of preconception health such as physical activity, avoidance of alcohol, and a healthy diet with the hopes of improving pregnancy outcomes.

In 1979, the United States (US) Department of Health, Education, and Welfare published one of the first federal position papers acknowledging the need for a national shift in its approach to prevention to pre-pregnancy care[23]. As the nation moved toward integrated and comprehensive services for perinatal prevention, several national initiatives and landmark publications were established in the 1980s. The Healthy Mothers Healthy Babies coalition was formed in 1981 by the American College of Obstetricians and Gynecologists (ACOG), the March of Dimes (MOD), the American Academy of Pediatrics (AAP), the American Nurses Association (ANA), the National Congress of Parents and Teachers, and the US Public Health Service to improve the quality and reach of public and professional education related to prenatal and infant care[24]. The Institute of Medicine (IOM) published *Preventing Low Birthweigh*t[25] noting several opportunities before pregnancy that were often overlooked in favor of interventions during pregnancy to reduce the risk of low birth weight. The IOM Committee supported the integration of family planning services as an essential component of effective preconception initiatives. In 1983, the AAP and ACOG in partnership with the MOD Birth Defects Foundation published the first *Guidelines for Perinatal Care*[26]. These guidelines were the first to note that at the time of conception the couple should be in optimal physical health and emotionally prepared for parenthood. In 1989, The Expert Panel on the Content of Prenatal Care, another federally appointed committee, indicated that preconception care is most effective when services are provided as part of general preventive care or during primary care visits for medical conditions.

Published in 1990, the national health promotion and disease prevention objectives for the United States, *Healthy People 2000*, moved preconception care into a standard expectation within the health care system with this specific objective: "Increase to at least 60% the proportion of primary care providers who provide age-appropriate preconception care and counseling"[27]. This objective supported the position of the 1989 Expert Panel on the Content of Prenatal Care and stressed the importance of preconception health promotion. In 1991, the Health Resources and Services Administration (HRSA) of the US Department of Health and Human Services (HHS) began the Healthy Start Initiative, another national program. The purpose of the Healthy Start Initiative was to identify and develop community-driven systems approaches to reducing infant mortality and improving the health and well-being of women, infants, children, and families[28]. The MOD Birth Defects Foundation introduced the concept of "reproductive awareness" as a promotion strategy to improve pregnancy outcomes in its 1993 publication entitled *Toward Improving the Outcome of Pregnancy: The 90s and Beyond*. This report spearheaded a new strategy to reach each woman of child-bearing age with a reproductive awareness message at every health encounter not just during obstetric or gynecologic visits[29]. In 1995, the ACOG published its first technical bulletin on preconception care, calling for thorough and systematic risk identification[30]. The bulletin also cautioned against overpromising the benefits of preconception care, noting that preconception services do not guarantee good pregnancy outcomes. Similar to previous reports on preconception care, ACOG recommended routine visits by every woman who has the potential to become pregnant as vital opportunities to emphasize the importance of preconception health and habits.

In 2002, the fifth edition of the AAP/ACOG *Guidelines for Perinatal Care* emphasized the integration of preconception health promotion into all health encounters during a woman's reproductive years[26]. In 2004, the CDC Workgroup on Preconception Health and Health Care launched the Preconception Health and Healthcare (PCHHC) Initiative[31]. The CDC Panel made recommendations aimed at achieving four goals: 1) to improve the knowledge, attitudes, and behaviors of men and women related to preconception health; 2) to assure that all women of reproductive age in the US receive preconception care services that will enable them to enter pregnancy in optimal health; 3) to reduce risks indicated by a pervious adverse pregnancy outcome through interventions during the interconception period; 4) to reduce the disparities in adverse pregnancy outcomes[15]. Recognizing the need to define the content of preconception care on the basis of scientific evidence, the CDC panel established five implementation workgroups (clinical, public health, consumer, policy and finance, and research and surveillance) to discuss opportunities and develop strategies for implementing the recommendations[31]. The initiative goals for each workgroup are described in Table 2.1.

Table 2.1 Goals for Each Workgroup of the Preconception Health and Health Care (PCHHC) Initiative, 2012–2014[32]

Workgroup	Initiative Goal(s)
Clinical	To assure that all U.S. women of childbearing age receive preconception care services – screening, health promotion, and interventions – that will enable them to achieve high levels of wellness, minimize risks, and enter any pregnancy they may have in optimal health. To reduce risks among women who have had a prior adverse maternal, fetal, or infant outcome through interventions in the postpartum/interconception period.

Consumer	To improve the knowledge, attitudes, and behaviors of men and women related to preconception health.
Public Health	To create health equity and eliminate disparities in adverse maternal, fetal, and infant outcomes. To assure that all U.S. women of childbearing age receive preconception care services – screening, health promotion, and intervention that will enable them to achieve high levels of wellness, minimize risks, and enter any pregnancy they may have in optimal health.
Policy and Finance	To create health equity and eliminate disparities in adverse maternal, fetal, and infant outcomes. To assure that all U.S. women of childbearing age receive preconception care services – screening, health promotion, and intervention that will enable them to achieve high levels of wellness, minimize risks, and enter any pregnancy they may have in optimal health.
Surveillance and Research	Overarching work and across all four goals, this group will focus on assessing and monitoring the population health status, providers' knowledge, access and quality of services.

The notion of preconception health and its significance has been documented since ancient times. However, the implementation of preconception health into the mainstream population in the US has been slower than expected given its historical background, key players, and acknowledged grand ideas. Additionally, there is little evidence on the effectiveness of the cumulative approach of preconception health on PTB.

Preconception Health Indicators

In 2007, the Public Health Workgroup (PHWG) of the CDC Preconception Health and Healthcare Initiative convened a committee of seven states to define preconception health domains and proposed a core list of valid and reliable preconception health indicators from currently available measures in national surveys and vital records data systems[33]. The PHWG identified 10 domains of preconception health and 45 core preconception health indicators. Of the 45 indicators, 24 used the pregnancy risk assessment monitoring system (PRAMS) as a data source while the remaining relied on other data sources such as the annual social and economic supplement (ASEC), the behavioral risk factor surveillance system (BRFSS), the national sexually transmitted diseases database (NSTD), and the national vital statistics systems (NVSS). To date, no study has utilized one data source to cumulatively describe preconception health and its relation to PTB at the state level.

With over 30 years of research, there is still a lack of consensus on measures to track quality of preconception care. Due to this lack of consensus, there has been a lag in clinical implementation of recommendations for improving preconception health and care in the US[34]. The Clinical Workgroup of the PCHHC Initiative proposed nine measures (Table 1.1) that index the healthcare system performance rather than of individual clinicians or practices, understanding that multiple healthcare providers, clinics, and public health programs deliver preconception care[34]. This workgroup defines preconception wellness (PCW) as a woman's level of well-being at the time of conception as influenced by her clinical and psychosocial status and environment at any point in time[34]. They also note that PCW is distinct from preconception care (Table 2.2). In comparison to the domains described by the public health workgroup, the clinical workgroup's nine measures fit into each domain of preconception health.

Table 2.2 Variation in Preconception Terminology

Term	Definition
Preconception care	The process of identifying social, behavioral, environmental, and biomedical risks to a woman's fertility and pregnancy outcome and reducing these risks through education, counseling, and appropriate intervention before conception[15,35]

Preconception health	The health of women of reproductive age before or between pregnancies[36]
Preconception wellness	A woman's level of well-being at the time of conception as influenced by her clinical and psychosocial status and her environment at any point in time[34]

Note: Given its encompassing definition, the term preconception wellness was used throughout this study.

Preconception Health and Preterm Birth

In the US, approximately 80% of reproductive-age women have dental disease, 66% are overweight or obese, 9% have diabetes, 6% asthma, 3% hypertension, and 3% cardiac disease[4]. In addition to suffering from these chronic conditions, a substantial proportion of pregnant women engaged in high risk behaviors such as smoking during pregnancy (11%) or alcohol consumption before pregnancy (55%) or during pregnancy (10%). Women also engaged in risky sexual behaviors, potentially exposing them to sexually transmitted diseases (STDs) and a smaller proportion used illicit drugs, which has been shown to be associated with adverse outcomes[37]. Oftentimes these behaviors co-occur, compounding the risk for adverse outcomes such as PTB. Several health promotion campaigns have aimed to reduce smoking, misuse of alcohol, intimate partner violence, obesity, human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS), vaccine-preventable diseases, and exposure to occupational hazards[15]. However, many US adults are still unaware of how these and other lifestyle factors influence reproductive health.

The preconception period is a critical time given that several risk behaviors and exposures during this period negatively affect fetal development and subsequent outcomes. For example, Hass and colleagues[38] have suggested that women's social determinants of health (SDOH) contribute to disparities in birth outcomes. In that study, the poorer physical and emotional health of women with a low income during the month prior to pregnancy was associated with an increased risk for preterm labor[38]. Other SDOH that directly and indirectly influence a women's wellness prior to conception include healthcare access, environmental exposure, and racial inequalities[39-42].

Epidemiology of Preterm Birth

In order to develop effective preventive strategies to reduce the incidence of PTB, a thorough understanding of its epidemiology and pathogenesis is warranted. A preterm birth is defined as a birth less than 37 completed weeks of gestation but more than 20 weeks or 259 days[43,44].

<u>Prevalence and Consequences of PTB</u>

In 2014, the rate of PTB (gestational age based on obstetric estimate) was 9.57% and the preliminary estimate for 2015 was 9.62%, a slight, but meaningful increase following over 5 years of decline[45,46]. PTB is associated with over 75% of all perinatal mortality and more than 50% of perinatal and long-term morbidity, with morbidity resulting in physical, psychological, and economic consequences for the family and society[47-49]. Short term morbidities associated with PTB include respiratory distress syndrome, intraventricular hemorrhage, periventricular leukomalacia, necrotizing enterocolitis, bronchopulmonary dysplasia, sepsis, and patent ductus arteriosus[50]. Long term morbidities include cerebral palsy, mental retardation, and retinopathy of prematurity[50]. The IOM estimated that the societal cost of PTB in the US was $26 billion per year, including medical care costs up to age 5 for children born preterm, maternal delivery costs, and the cost of early intervention[51,52].

Types of Prematurity

The obstetric precursors leading to the birth of an infant less than 37 weeks' gestation include 1) spontaneous labor with intact membranes, 2) preterm premature rupture of the membranes (PPROM), and 3) labor induction or caesarean delivery for maternal or fetal indications[47,53,54]. Births resulting from spontaneous labor with intact membranes (45%) and PPROM (25%) can be broadly categorized as spontaneous preterm births (SPTBs) and deliveries where labor is induced or an infant is delivered by pre-labor caesarean section (30%) are classified as medically-induced preterm birth (MIPTB). Utilizing the standardized definition of the precursors for PTB is essential to effective assessment of PTB[54].

Measurement Challenges

Estimation of infant's gestational age, which then drives determination of PTB, has changed over time. While last menstrual period (LMP) has been widely used clinically in the past, obstetric estimate of gestation at delivery (OE) was introduced in 2003 as the best estimate of an infant's gestation in completed weeks based on the birth attendant's final estimate of gestation[55,56]. Data including the OE estimate in lieu of the date of a mother's LMP have been included in NVSS since 2007 and has been thought to improve monitoring of gestational age trends, identification of population disparities in PTB, mortality risk estimation by gestational age and understanding of the etiology of PTB[55]. The trends in the data remain similar, PTB rates have declined for both the OE- and the LMP-based measures but the decline in the OE rate was slightly smaller than the LMP. In 2014, Georgia was the 6th state with the highest PTB rate

(10.8 per 1000)[57]. From 2007 to 2015, PTB rates in Georgia have been slightly higher than the national average but both have been declining over the years (Figure 2.1).

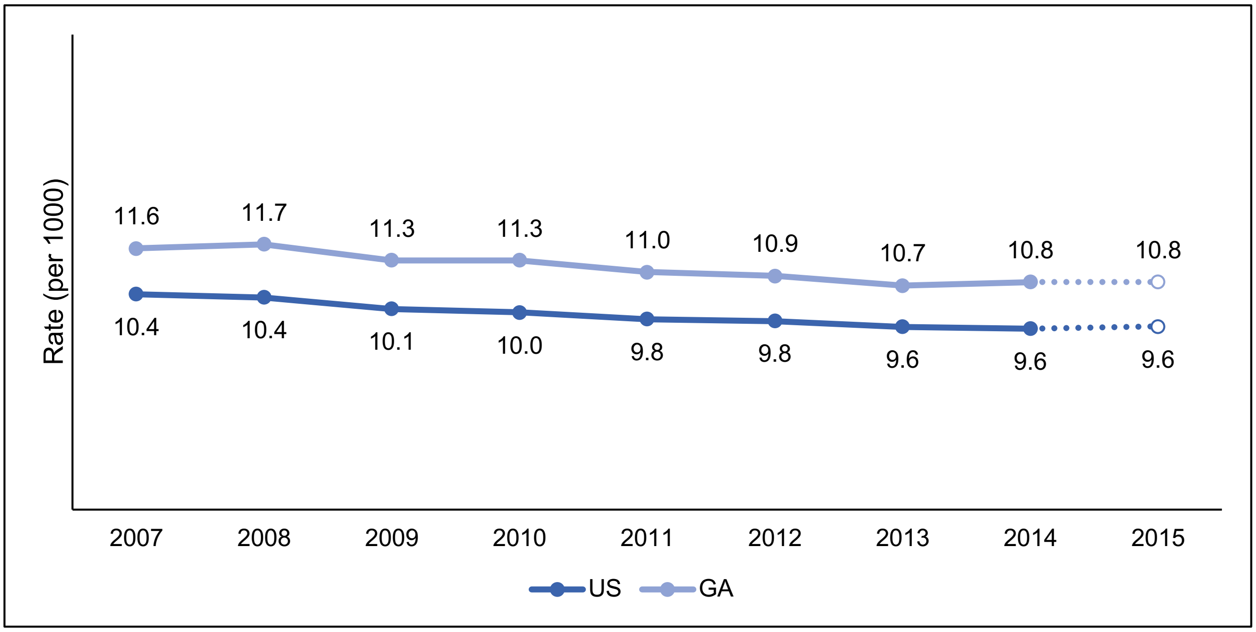

Figure 2.1. Preterm Birth Rate Confirmed by Obstetric Estimate [a] in the United States and Georgia, by Year, 2007-2015
[a] *Beginning in 2014, the National Center for Health Statistics used obstetric estimate to approximate the gestational age of a newborn. Previous data were available up to 2007 [55].*
[b] *Only preliminary data is available for 2015 [46].*

Risk Factors for PTB

Many behavioral risk factors have been linked to PTB overall, including individual or family history of PTB, tobacco and alcohol consumption, advanced maternal age, short inter-pregnancy intervals, low maternal body-mass index (BMI), multiple pregnancy, pre-existing non-communicable disease, and hypertensive disease of pregnancy and infections[54,58-60]. Despite efforts to address these risk factors, PTB remains the most common cause of neonatal death and the second most frequent cause of death in children less than 5 years[52,59]. In the US, the preliminary PTB rate for

2015 was 9.62 per 1000, a substantial decline since its peak in 2006 at 12.8 per 1000 but the first increase in this rate since 2007[46].

Racial and Ethnic Disparities in PTB

Substantial differences exist by racial and ethnic group in PTB (Figure 2.2). In the US in 2014, non-Hispanic (NH) Black infants had a PTB rate of 13.2 per 1000 live births and Hispanic infants had a rate 9.0 per 1000 live births; these rates were slightly higher than the PTB rate of White infants (8.9 per 1000 live births)[45]. In Georgia similar disparities exist, with the highest burden of PTB among NH Black infants (13.7 per 1000); however, Hispanic infants had a slightly lower rate of PTB (9.2 per 1000) compared to White infants (9.3 per 1000) in Georgia[8].

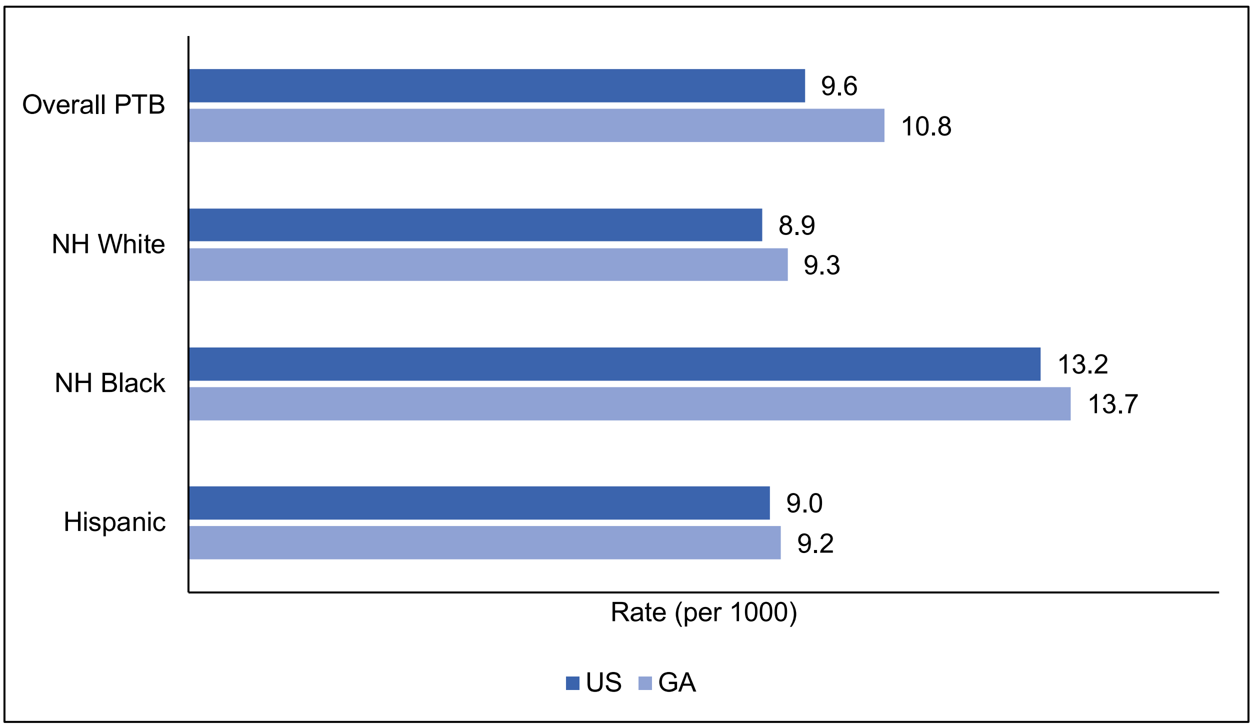

Figure 2.2. Racial and Ethnic Preterm Birth Rates in the United States[45] and Georgia[8], 2014

The factors that reinforce the racial disparity in the PTB rate often spark controversy pitting biomedical and sociologic approaches rather than determining suitable interventions[61]. Researchers Culhane and Goldenberg from the University of North Carolina developed a more comprehensive definition of disparity. Disparities are "inequities in disease and well-being that come from discrimination and unequal access to society's benefits, such as quality education, good jobs, decent and affordable housing, safe neighborhoods and environments, nutritious foods, and adequate healthcare. These inequities result in disproportionately higher rates of death, disease, and disability and have adverse consequences on the physical, mental, spiritual, and social well-being of population groups, who historically and currently, do not experience equivalent social advantage"[62]. Culhane and Goldenberg go on to suggest that real improvements in disparities may be realized once research utilizes the UNC definition of disparity to influence policy and program development in areas not traditionally considered health-related, such as housing and education[61].

Identifying Gaps in the Literature

The current literature positively demonstrates the impact of independent preconception health indicators on PTB. However, preconception health behaviors are not mutually exclusive. The literature has yet to demonstrate the effectiveness of the cumulative impact of preconception health indicators on reducing a woman's risk of delivering a preterm infant, especially in the context of social determinants of health disparities.

This study examines the feasibility of using one surveillance system, specifically PRAMS, to describe preconception wellness in the state of Georgia. Researchers have utilized multiple data sources simultaneously such as BRFSS and PRAMS when describing preconception health to account for indicators measured with one system over another[33,36]. While concurrently utilizing multiple data sources cover all aspects of preconception health, availability of multiple datasets may be a hindrance to many states. Additionally, aggregating data across data sources to generalize preconception health cumulatively can be challenging due to the difference in methodology across state surveillance systems.

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CHAPTER 3

METHODS

Specific Aims

Our first aim was to examine the distribution of preconception wellness (PCW) indicators as defined by the Clinical Workgroup of the National Preconception Health and Health Care Initiative among women who participated in the Georgia Pregnancy Risk Assessment Monitoring System from 2009-2013. Our second aim was to examine the association between PCW indicators and preterm birth (PTB) among Georgia mothers. Our third aim was to examine the association between PCW and PTB clinical subtypes as previously defined.

Study Design

The analysis of this surveillance data employed a non-experimental study design using cross-sectional data collection. Cross-sectional studies are carried out at one time point or over a short period of time, usually to estimate the prevalence of the outcome of interest within a specific population[1]. This design is ideal for this study because it allows for many risk factors to be assessed and since PTB is known to be multifaceted, being able to evaluate the impact of all potential risk factors is needed. However, cross-sectional studies have their limitations. Because cross-sectional studies are carried out at one time point and give no indication as to whether an exposure occurred before, after, or during the onset of the outcome of interest, inferring causality is challenging if not impossible[1].

Data Source

Georgia Pregnancy Risk Assessment Monitoring System (PRAMS) data were obtained from 2009-2013 from the Georgia Department of Public Health. The overall goal of Georgia PRAMS is to reduce infant morbidity and mortality and to promote maternal health by influencing maternal and child health programs, policies, and maternal behaviors during pregnancy and early infancy[2]. PRAMS data can lead to improvements in the health of mothers and infants in Georgia. PRAMS data are derived from three sources: birth certificate data, operational data, and questionnaire data. All three sources of data are combined to create a final, weighted PRAMS analysis dataset[2]. PRAMS was designed to supplement birth certificate data on selected maternal behaviors and experiences that occurred before, during, and after pregnancy[3]. Operational data are used to calculate response rates and to monitor the quality of project operations. The PRAMS questionnaire serves as the primary source of maternal behavioral information for the time before, during, and after the mother's most recent pregnancy.

Data Collection

Georgia PRAMS ongoing surveillance combines two modes of data collection: mail and telephone. Because of advantages of mail surveillance such as cost and ready access to mailing addresses, this mode was used as the primary form of data collection[2]. Up to three self-administered surveys are mailed to participants. Women who do not respond to the mailings were followed up by telephone and encouraged to complete a telephone interview (Table 3.1). Telephone follow-up for mail can substantially add to the total number of completed questionnaires Georgia obtains. Data available from 19 PRAMS states in 2000 showed that telephone follow-up increased the overall response rate by an average of 15%, with a range of 4% to 25%[2]. The combination of multiple contacts and mixed data collection modes has been effective in increasing response rates in many populations[2]. The specific modes selected for PRAMS complement one another to maximize response rates while minimizing cost.

Table 3.1. Georgia PRAMS Data Collection Cycle

Action	*Recommended Time Frame*	*Georgia's Schedule*
Mail preletter[1]	Day 1	Day 1
Mail 1st questionnaire	3-7 days after preletter	Day 8
Mail tickler[2]	7-10 days after first questionnaire	Day 18
Mail 2nd questionnaire	7-14 days after tickler	Day 25
Mail 3rd questionnaire	7-14 days after second questionnaire	Day 39
Initiate telephone calls	7-14 days after third questionnaire	Day 53
End data collection	21-35 days after initiating phone	Day 93

[1]The preletter is a brief letter sent in advance of the questionnaire introducing the participant to the PRAMS project and informing her that a survey is forthcoming
[2]The tickler is sent to non-respondents after the first survey to remind them to complete the questionnaire and offer thanks in case she already has.

The Georgia PRAMS questionnaire has been revised several times throughout the life of the project. The development of the questionnaire is a collaborative process between Georgia, CDC and other maternal and child health colleagues. The Georgia PRAMS questionnaire consists of core questions (questions included on all states' surveys) and standard questions (additional questions chosen by the state from a list of standard questions provided by CDC)[2].

Study Population

Each month, the Georgia Department of Public Health draws a systematically random sample of approximately 100-200 women from Georgia's birth certificate data. PRAMS sites oftentimes oversample subpopulations to draw stronger conclusions about various factors of interest. Throughout this study period, Georgia PRAMS has oversampled on a variety of factors: infant birthweight (low vs. normal), maternal age (teenage vs. other), and county of residence (6 counties identified as infant mortality clusters in 2012)[4]. Between 2009 and 2013, 8,314 women were invited to participate in Georgia PRAMS and 5,447 completed the survey. The survey response rate for each year met the CDC threshold of 65%, ranging from 65.2% to 66.1% with an overall unweighted response rate of 65.5%.

Study Inclusion/Exclusion Criteria

The population of interest for Georgia PRAMS was all resident mothers who delivered a live-born infant during the surveillance period[2]. For Georgia resident women who have a live birth outside of the state, there were often substantial delays in obtaining birth certificate information from other states. In most cases these records were obtained too late to be sampled and followed up within the two- to six-month time frame utilized by the PRAMS protocol. Therefore, the sampling frame was restricted to infants who were delivered in Georgia. Subsequently, due to the difficulties in tracing in-state births to nonresident mothers, they were excluded from the sampling frame. Furthermore, Georgia's target population for public health action does not extend beyond its residents. Resident information is more relevant for better serving the public health needs of Georgians.

Infants whose birth certificates were missing the mother's last name were excluded from the sampling frame because this information is crucial for follow-up. Birth certificates that were only missing a mailing address were not excluded because this information can oftentimes be obtained from another source such as the Newborn Screening Database or the Women, Infant, and Children (WIC) Program database[2]. Birth certificates missing any other information were not excluded from the sampling frame.

Birth certificates that were processed more than six months after the birth occurred were excluded from the sampling frame. Use of such records raise concerns regarding recall bias, ability to locate the mother, and comparability with other respondents. From the date the sample was drawn, birth certificates of infants that were less than two months old were temporarily excluded but were included in the sampling frame two months after the birth.

The issue of multiple gestation in the sampling frame is complex. These infants are of interest because of the elevated rates of low birth weight and infant mortality. However, infants of a multiple gestation have had the same intrauterine environment, thus are not independent of one another. It was necessary to establish measures that ensured only one infant of a multiple gestation was included in the sampling frame. For each twin or triplet set, one member was randomly selected for inclusion in the sampling frame. If one of the deliveries resulted in a fetal death, the surviving twin or triplet(s) was included. Multiple gestations involving four or more siblings were excluded from the sampling frame. Because of the rarity of multiple births of this number, little is lost in representing the population[2]. Quadruplets and quintuplets are almost always below normal birthweight, but not because of risk factors that are of interest in epidemiologic studies. Alerted to possible complications, the mother most likely received more than the usual prenatal care.

The sampling of adopted infants can be a sensitive issue. In Georgia, the adoptive mother was often named on the birth certificate. Given that the majority of the survey questions involve the time period prior to and during the pregnancy, the adoptive mother was not qualified to respond to the PRAMS survey. For this reason, any adoptions that were identified as such on the birth certificate were excluded from the sample.

Current medical technology has made it possible for couples to have a baby through surrogacy. Unlike the process of adoption, no legal consensus has been reached about surrogate motherhood in the United States[5]. As a result, the sampling of an infant delivered by a surrogate carrier (or gestational carrier) can be a sensitive issue. Under certain circumstances the intended mother (the woman who will raise the child) is named on the birth certificate. Since the majority of survey questions involve the time period prior to and during the pregnancy, the intended mother is not qualified to respond to the PRAMS survey. For this reason, any births that can be identified as such were excluded from the sample.

Human Subjects Research

This research was conducted according to prevailing ethical principles and was reviewed by the Georgia Department of Public Health and the University of Georgia Institutional Review Boards and have been performed in accordance with the ethical standards as laid out in the 1964 Declaration of Helsinki and its later amendments.

Survey Response and Sample Size

Response rates are critical to the quality of a surveillance system such as PRAMS. The goal of PRAMS surveillance activities is to obtain completed interviews for 100% of sampled women[2]. Starting with the 2007 data, the minimum acceptable overall weighted response rate for analysis of PRAMS data was 65%. Because of nonresponse, actual sample sizes for PRAMS must be larger to achieve a given level of precision in epidemiologic measurements. Larger sample sizes reduce the random error in estimates obtained from PRAMS. However, increasing sample sizes does not compensate for response bias. Nonrandom or systematic error from response bias can only be reduced by improving response rates[2].

Georgia PRAMS data are weighted to adjust for nonresponse patterns because response rates vary among strata. However, weights may not adequately compensate for low response rates. The nonresponse weight assumes that the average of the answers of the respondents within a particular stratum and response category under consideration is the same as the average of the answers for the non-respondents in that stratum and response category[2]. Whereas this assumption is reasonable for strata with response rates of 65% or higher, it becomes increasingly implausible for strata with lower response rates. Georgia PRAMS data have reached the CDC response rate threshold for the included years of data, 2009-2013.

Statistical Analysis (Aim 1)

The primary objective for Specific Aim 1 was to examine the distribution of preconception wellness indicators as defined by the Clinical Workgroup of the National Preconception Health and Health Care Initiative among women who participated in the

Georgia Pregnancy Risk Assessment Monitoring System from 2009-2013. It was hypothesized that Georgia PRAMS data from 2009-2013 can be used to describe the prevalence of PCW among Georgia women.

Maternal characteristics, behaviors, and attitudes were presented (Table 3.2) and Rao-Scott chi-square tests for weighted data were performed in order to detect statistical differences (p<0.05) between all maternal characteristics and PCW categories. Logistic regression models assessed the experience of each preconception wellness indicator by significant maternal characteristics. Prevalences and 95% confidence intervals were presented with their corresponding p-values. Associations were considered statistically significant at alpha = 0.05. All data were analyzed in SAS 9.4 (SAS Institute, Cary, NC) and SAS-Callable SUDAAN 11.0.1 (Research Triangle Institute, Research Triangle Park, NC).

Table 3.2. Georgia Pregnancy Risk Assessment Monitoring System (PRAMS) Data Elements and Response/Answer Choices by Category, 2009-2013

Category	*Variable Name*	*Response/Answer Choice*
Pregnancy Complications	Premature rupture of membranes (PROM)	1 = No 2 = Yes
	Medical Risk Factor[1]	1 = No 2 = Yes
Maternal Characteristics	Age (in years)	1 = < 20 2 = 20 - 29 3 = 30 +
	Race/ethnicity	1 = Non-Hispanic, White 2 = Non-Hispanic, Black 3 = Non-Hispanic, Other 4 = Hispanic
	Education	1 = < High School 2 = High School Graduate 3 = Some College 4 = College Graduate

	Marital status	1 = Not Married 2 = Married
	Urban/Rural status	1 = Urban 2 = Rural
	Delivery payment type	1 = Private Insurance 2 = Medicaid 3 = Other
	Pre-pregnancy body mass index (BMI)	1 = Underweight (< 18.5) 2 = Normal (18.5 - 24.9) 3 = Overweight (25.0 - 29.9) 4 = Obese (30.0 +)
	Pre-pregnancy health insurance	1 = Private Insurance 2 = Medicaid 3 = Other
Maternal Behaviors	Prenatal care within 1st trimester	1 = No 2 = Yes 3 = No prenatal care
	Folic Acid Use	1 = Didn't take vitamin 2 = 1 - 3 times/week 3 = 4 - 6 times/week 4 = Everyday
	Avoidance of tobacco	1 = No 2 = Yes
	Absence of sexually transmitted infection	1 = No 2 = Yes
	Taking regular prescription medication	1 = No 2 = Yes
Maternal Health Conditions	Diabetes screening/treatment	1 = No 2 = Yes
	Depression screening/treatment	1 = No 2 = Yes
Maternal Attitudes	Pregnancy Intention	1 = Intended 2 = Unintended

[1] Medical risk factor is any of the following: pre-pregnancy or gestational hypertension, pre-pregnancy or gestational diabetes, a previous preterm birth, vaginal bleeding, or previous pregnancy outcomes

Statistical Analysis (Aim 2)

The primary objective for Specific Aim 2 was to examine the association between PCW indicators as defined by Clinical Workgroup and preterm birth (PTB) among Georgia mothers. Maternal characteristics, behaviors, and attitudes were presented (Table 3.2) and Rao-Scott chi-square tests for weighted data were performed to detect statistical differences between PCW indicators and PTB. To assess experiences of each PCW indicator and its association with PTB, logistic regression models accounting for varying covariate adjustment levels were run. Because of the potential co-occurrence of PCW indicators, other specific PCW indicators were added as covariates to evaluate each PCW indicator's independent effect. To assess the experience a cumulative number of PCW indicators and PTB, weighted logistic regression models were performed to assess the association between cumulative PCW indicators and PTB with and without adjusting for significant covariates and confounders such as maternal demographics and pregnancy complications.

Variables were evaluated for potential confounding using a two-stage process. First, univariate unconditional logistic regression models for weighted data were evaluated for each independent variable. Variables were considered for inclusion at $p<0.20$ and were then included as covariates in a multivariable statistical model. Variables were selected for inclusion in the final model using manual forward selection. Variables were retained if their addition to the full model resulted in a significant difference ($p<0.05$) in the -2 log likelihood of the full and reduced models or based on *a priori* knowledge.

Odds ratios (OR) and their corresponding 95% confidence intervals (CI) were presented. Associations were considered statistically significant if the CI for the corresponding OR did not include 1. Table 3.3 illustrates the logistic regression model components and the formula for the full regression model for Specific Aim 2. SAS 9.4 (SAS Institute, Cary, NC) and SAS-Callable SUDAAN 11.0.1 (Research Triangle

Institute, Research Triangle Park, NC) were utilized to account for the complex survey weights and to conduct all statistical analyses.

Table 3.3. Regression Model Components for Full Regression Model for Specific Aim 2

Outcome of Interest	Y_{PTB} = Preterm Birth	Yes vs. No
List of Risk Factors	X_1 = Cumulative Preconception Wellness (PCW) indicators	1-3 PCW indicators experience vs. 4-6/7-9 indicators experienced
	X_2 = Race/ethnicity	Non-Hispanic White vs. NH Black/NH Other/Hispanic
	X_3 = Age	< 20 years old vs. 20-29 years old/30+ years old
	X_4 = Marital Status	Married vs. Other
	X_5 = Medical Risk Factor	Yes vs. No
	X_6 = Pre-pregnancy Insurance	Yes vs. No
	$X_{7a\text{-}h}$ = PCW Indicators	Pregnancy Intention, Access to care, Folic acid use, Tobacco avoidance, Absence of uncontrolled depression, absence of STI, healthy weight, optimal glycemic control, teratogen avoidance in chronic conditions

$$Y_{PTB} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_{7a\text{-}h} + \varepsilon$$

Statistical Analysis (Aim 3)

The primary objective for Specific Aim 3 was to examine the association between preconception wellness (PCW) and preterm birth (PTB) clinical subtypes as previously defined[6]. Given the distinct etiologic heterogeneity of the PTB clinical subtypes, we hypothesize that the more cumulative PCW indicators a woman experiences decreases her odds of either spontaneous or medically induced PTB.

Maternal characteristics, behaviors, and attitudes were presented (Table 3.2) and Rao-Scott chi-square tests for weighted data were performed to detect statistical differences between PCW indicators and each PTB clinical type. To assess maternal characteristics and its association with PTB subtypes, logistic regression models accounting for varying covariate adjustment levels were run. Variables were selected for inclusion in the final model using manual forward selection. Variables were retained if their addition to the full model resulted in a significant difference ($p<0.05$) in the -2 log likelihood of the full and reduced models or based on a priori knowledge.

Odds ratios (OR) and their corresponding 95% confidence intervals (CI) were presented. Associations were considered statistically significant if the CI for the corresponding OR did not include 1. Table 3.4 illustrates the logistic regression model components and the formula for the full regression model for Specific Aim 3. SAS 9.4 (SAS Institute, Cary, NC) and SAS-Callable SUDAAN 11.0.1 (Research Triangle Institute, Research Triangle Park, NC) were utilized to account for the complex survey weights and to conduct all statistical analyses.

Table 3.4. Regression Model Components for Full Regression Model for Specific Aim 3

Outcome of Interest	Y_i^* = Preterm birth (PTB) overall; by subtype	Yes vs. No; spontaneous vs. medically-induced preterm birth
List of Risk Factors	X_1 = Cumulative Preconception Wellness (PCW) Indicators	1-3 PCW indicators experience vs. 4-6/7-9 indicators experienced
	X_2 = Race/ethnicity	Non-Hispanic White vs. NH Black/NH Other/Hispanic
	X_3 = Age	< 20 years old vs. 20-29 years old/30+ years old
	X_4 = Marital Status	Married vs. Other
	X_5 = Medical Risk Factor	Yes vs. No
	X_6 = Primiparious	Yes vs. No
	$X_{7a\text{-}h}$ = PCW Indicators	Pregnancy Intention, Access to care, Folic acid use, Tobacco avoidance, check/treatment of depression, absence of STI, healthy weight, check/treatment of diabetes, teratogen avoidance in chronic conditions

$Y_{PTB} = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_{7a\text{-}h} + \varepsilon$

$Y_{SPTB} = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_{7a\text{-}h} + \varepsilon$

$Y_{MIPTB} = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_{7a\text{-}h} + \varepsilon$

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CHAPTER 4

UTILIZING THE GEORGIA PREGNANCY RISK ASSESSMENT MONITORING SYSTEM TO EXAMINE PRECONCEPTION WELLNESS AMONG GEORGIA MOTHERS[1]

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Abstract

Background: A woman's level of wellbeing at the time of conception as influenced by her clinical and psychosocial status and environment, known as preconception wellness, can improve pregnancy outcomes. This study examined the distribution of preconception wellness indicators among Georgia women who recently gave birth to a live infant.

Methods: Data were collected during 2009-2013 in the Georgia Pregnancy Risk Assessment Monitoring System (PRAMS), a state specific population-based surveillance system that collects data on select maternal behaviors and experiences occurring before, during, and shortly after pregnancy. A total of 5,192 Georgia moms were included in this analysis. Nine preconception wellness indicators as defined by the Clinical Workgroup of the CDC Preconception Health and Healthcare Initiative were examined, including pregnancy intention, access to care, folic acid use, tobacco avoidance, depression screening/treatment, diabetes screening/treatment, healthy weight, absence of sexually transmitted infections, and teratogen avoidance. Preconception wellness indicators experienced per mom were summed and categorized as 1-3, 4-6, and 7-9 for analysis. Descriptive statistics, bivariate analyses, and logistic regression models assessed the experience of each preconception wellness indicator by significant maternal characteristics.

Results: The preconception wellness indicators experienced ranged from 7.7% (depression screening/treatment) to 96.9% (absence of sexually transmitted infection). Overall, the majority of Georgia moms (74.5%) experienced 4-6 PCW indicators at least one month before their new baby was conceived. Georgia moms who were 30 years of age or older, non-Hispanic (NH) White or NH Other, college graduates, residing in an urban county, had health insurance before pregnancy, and used private insurance to pay for their delivery were more likely to experience 7 to 9 PCW indicators.

Conclusion: By applying the Clinical Workgroup's concept of preconception wellness to Georgia PRAMS, we could better understand preconception wellness among Georgia moms. Findings can allow for statewide targeted efforts within programs to improve preconception wellness.

Key words**:** preconception wellness, PRAMS, maternal behaviors, pregnancy

Introduction

For over two decades, prenatal care has been a cornerstone to the United States' (US) strategy for improving pregnancy outcomes due to evidence suggesting prenatal care reduces the risk of having a low birth weight and preterm infant[1-6]. However, in recent years the effectiveness of this strategy has been called into question, arguing that a woman's first prenatal visit may be too late to start caring for a pregnancy[7]. Due to the proportion of unintended pregnancy in the US (45% in 2011), exposure to potential teratogens may have unknowingly already occurred by the first prenatal care visit, ideally by 10 weeks of pregnancy[8,9].

Furthermore, expecting the short period of prenatal care to reverse the impact of early life programming and cumulative allostatic load on a woman's reproductive health may be impractical[5]. There is a growing consensus that preconception care, rather than prenatal care, throughout the life course is the ideal practice. However, preconception care may also be "too little too late" if it is provided in a single visit shortly before a planned pregnancy rather than as an integral part of a woman's health care continuum throughout her life course[1,2].

There is a lack of consensus on measures to track quality of preconception care. Due to this, Frayne et al[10] argued that there has been a lag in clinical implementation of recommendations for improving preconception health and care in the US. The Clinical Workgroup of the Centers for Disease Control and Prevention (CDC) Preconception Health and Healthcare (PCHHC) Initiative proposed nine measures that index the healthcare system performance rather than of individual clinicians or practices, understanding that multiple healthcare providers, clinics, and public health programs deliver preconception care[10]. This workgroup defines preconception wellness as a woman's level of well-being at the time of conception as influenced by her clinical and psychosocial status and environment at any point in time[10].

The purpose of this paper was to determine the feasibility of examining the distribution of preconception wellness indicators among women who participated in the Georgia Pregnancy Risk Assessment Monitoring System from 2009-2013. To date, no study has utilized one sole data source to apply the Clinical Workgroup's conceptualization of preconception wellness to state level data. Determining the distribution of preconception wellness in the state can provide Georgia with a baseline for how healthy mothers are prior to pregnancy.

Methods

Data Source

Georgia Pregnancy Risk Assessment Monitoring System (PRAMS) data from 2009-2013 were obtained from the Georgia Department of Public Health. PRAMS is a multi-state, population-based surveillance system conducted by states in collaboration with CDC. PRAMS was designed to supplement birth certificate data on selected maternal behaviors and experiences that occurred before, during, and after pregnancy[11]. Georgia PRAMS collects information on Georgia resident women who deliver a live infant to improve the health of mothers and babies in Georgia.

Study Participants

Each month, the Georgia Department of Public Health draws a stratified random sample of approximately 100-200 women from Georgia's birth certificate registry.

PRAMS data were weighted by CDC to ensure that the sample drawn by the Georgia Department of Public Health was representative of all women who had a live birth in Georgia. Questionnaires were then mailed to the sampled women within two to six months post-delivery, and follow-up attempts to collect data via phone were made for mail non-responders[12]. Between 2009 and 2013, 8,325 women were invited to participate in Georgia PRAMS and 5,453 completed the survey. The survey response rate for each year met CDC's threshold of 65%, ranging from 65.2% to 66.1% with an overall unweighted response rate of 65.5%. This research was reviewed and approved by the Georgia Department of Public Health and the University of Georgia Institutional Review Boards.

Preconception Wellness Indicators

Preconception wellness (PCW) indicators were summarized in Table 1 and based on questions about events that may have occurred at least 1 month before the new baby was conceived. These indicators were adapted from the Clinical Workgroup of the CDC Preconception Health and Healthcare Initiative[10]. PCW indicators include pregnancy intention, access to care, folic acid use, tobacco avoidance, depression screening/treatment, diabetes screening/treatment, healthy weight, absence of sexually transmitted infections (STIs), and teratogen avoidance.

Maternal Characteristics

For this analysis, maternal age was categorized as less than 20 years of age, 20-29 years of age, and 30 years of age or older. Maternal race/ethnicity was classified as either Hispanic or non-Hispanic (NH), and non-Hispanic was categorized as NH White, NH Black, or NH Other (e.g., Asian, Native American, mixed race). Maternal education was categorized as less than high school, high school graduate, some college, and college graduate. Marital status was categorized as married or unmarried at the time of conception or birth. Payment for delivery was used as a proxy for socioeconomic status and categorized as private insurance, Medicaid, or other (e.g., self-pay, Tricare, etc.). Urban/Rural status was determined by the urban/rural status of the county where participants resided at time of delivery. Medical risk factor was designated as yes/no where medical risk factor was coded ‘yes’ if a participant had pre-pregnancy or gestational hypertension or diabetes, a previous preterm birth, vaginal bleeding, or previous adverse pregnancy outcomes.

All PCW indicators except absence of STI were ascertained from the Georgia PRAMS questionnaire. The remaining variables were ascertained from Georgia birth certificate data, including maternal race/ethnicity, age, education, marital status, payment for delivery, urban/rural status, medical risk factor, and STI presence/treatment during pregnancy.

Statistical Analysis

SAS 9.4 (SAS Institute, Cary, NC) and SAS-Callable SUDAAN 11.0.1 (Research Triangle Institute, Research Triangle Park, NC) were used to account for the complex survey weights and conduct all statistical analyses. Rao-Scott chi-square tests for weighted data were performed to detect statistical differences ($p<0.05$) between all maternal characteristics and PCW categories. Logistic regression models assessed the experience of each preconception wellness indicator by significant maternal characteristics. Participants were excluded from analysis if they did not respond to the Georgia PRAMS questionnaire (N = 2,872).

Results

A total of 5,453 women responded to the Georgia PRAMS survey from 2009-2013. Results were presented by each preconception wellness indicator as described by the Clinical Workgroup of the CDC Preconception Health and Healthcare Initiative[10]. Characteristics of the study sample by each PCW indicator were described in Table 2.

Pregnancy Intention

From 2009-2013, the overall prevalence of intended pregnancy was 49.2%. The prevalence of this indicator varied by maternal characteristics. Specifically, 64.4% of mothers who were 30 years of age or older, compared to 23.4% of mothers aged 20 years or less, intended their pregnancy. Additionally, significantly higher proportions of intended pregnancy were observed among mothers who were college graduates (69.1%), married (65.3%), had health insurance before pregnancy (54.8%), and used private insurance as payment for delivery (68.8%). When assessing pregnancy intention by significant maternal characteristics, decreased odds of intending their pregnancy were observed among mothers who were less than 20 years of age [OR=0.38; 95% CI: 0.28-0.51], NH Black [OR=0.32; 95% CI: 0.26-0.39], unmarried [OR=0.24; 95% CI: 0.20-0.29], did not graduate college [OR=0.31; 95% CI: 0.26-0.39], residing in a rural county [OR=0.76; 95% CI: 0.63-0.93], had no health insurance before pregnancy [OR=0.54; 95% CI: 0.45-0.65], and used Medicaid as payment for delivery [OR = 0.23; 95% CI: 0.39-0.68]. Increased odds of pregnancy intention were observed among mothers who were 30 years of age or older [OR=2.21; 95% CI: 1.83-2.67].

Access to Care

From 2009-2013, the overall prevalence for access to care was 82.8%. The prevalence of this indicator varied by maternal characteristics. Specifically, 90.8% of mothers who were non-Hispanic (NH) White, compared to 67.9% of Hispanic mothers, had access to care. Additionally, significantly higher proportions of access to care were observed among mothers who were 30 years of age or older (88.4%), college graduates (96.2%), married (89.2%), had health insurance before pregnancy (88.6%), and used private insurance as payment for delivery (95.9%). When assessing access to care by significant maternal characteristics, decreased odds of prenatal care within the first trimester were observed among mothers who were less than 20 years of age [OR=0.50; 95% CI: 0.35-0.63], NH Black [OR=0.40; 95% CI: 0.27-0.49] or Hispanic [OR=0.20; 95% CI: 0.15-0.30], unmarried [OR=0.40; 95% CI: 0.29-0.47], did not graduate college [OR=0.10; 95% CI: 0.09-0.22], had no health insurance before pregnancy [OR=0.30; 95% CI: 0.27-0.43], and used Medicaid as payment for delivery [OR = 0.10; 95% CI: 0.09-0.20]. Increased odds of access to care were observed among mothers who were 30 years of age or older [OR=1.70; 95% CI: 1.25-2.18].

Folic Acid Use

From 2009-2013, the overall prevalence of folic acid use was 37.8%. The prevalence of this indicator varied by maternal characteristics. Specifically, 45.8% of mothers who were non-Hispanic (NH) White, compared to 29.1% of NH Black mothers, used folic acid. Additionally, significantly higher proportions of folic acid use were observed among mothers who were 30 years of age or older (54.0%), college graduates (63.6%), married (51.2%), had health insurance before pregnancy (47.3%), and used private insurance as payment for delivery (56.8%). When assessing folic acid use by significant maternal characteristics, decreased odds of folic acid use were observed among mothers who were less than 20 years of age [OR=0.52; 95% CI: 0.37-0.71], NH Black [OR=0.48; 95% CI: 0.39-0.59] or Hispanic [OR=0.52; 95% CI: 0.39-0.68], unmarried [OR=0.28; 95% CI: 0.23-0.33], did not graduate college [OR=0.23; 95% CI: 0.19-0.28], had no health insurance before pregnancy [OR=0.30; 95% CI: 0.25-0.37], and used Medicaid as payment for delivery [OR = 0.24; 95% CI: 0.19-0.29]. Increased odds of access to care were observed among mothers who were 30 years of age or older [OR=2.6; 95% CI: 2.15-3.15].

<u>Tobacco Avoidance</u>

From 2009-2013, the overall prevalence of tobacco avoidance use was 81.8%. The prevalence of this indicator varied by maternal characteristics. Specifically, 93.4% of Hispanic mothers and 91.6 of NH Other such as Asian or Native American, compared to 74.0% of NH White mothers, did not use tobacco. Additionally, significantly higher proportions of tobacco avoidance were observed among mothers who were 30 years of age or older (88.0%), college graduates (90.1%), married (85.9%), and resided in an urban county (83.6%). When assessing tobacco avoidance by significant maternal characteristics, increased odds of avoiding tobacco were observed among mothers who were 30 years of age or older [OR=1.98; 95% CI: 1.52-2.57] and NH Black [OR=2.11; 95% CI: 1.62-2.75] or Hispanic [OR=5.06; 95% CI: 3.11-8.24]. Decreased odds of tobacco avoidance were observed among mothers who were unmarried [OR=0.55; 95% CI: 0.44-0.70], did not graduate college [OR=0.40; 95% CI: 0.29-0.55], resided in a rural county [OR=0.63; 95% CI: 0.50-0.81], and used Medicaid as payment for delivery [OR = 0.40; 95% CI: 0.31-0.53].

Depression Screening/Treatment

From 2009-2013, the overall prevalence of depression screening/treatment was 7.7%. The prevalence of this indicator did not vary much by maternal characteristics. The only variation observed was by health insurance coverage before pregnancy. Mothers who had health insurance before pregnancy had significantly higher proportions of depression screening/treatment compared to mothers who did not have health insurance before pregnancy (9.4% vs 4.9%, respectively). When assessing depression screening/treatment by significant maternal characteristics, decreased odds of depression screening/treatment were observed among mothers Hispanic [OR=0.32; 95% CI: 0.17-0.60], did not graduate college [OR=0.59; 95% CI: 0.42-0.81], and had no health insurance before pregnancy [OR=0.50; 95% CI: 0.34-0.71]. Increased odds of depression screening/treatment were observed among mothers who were 30 years of age or older [OR=1.53; 95% CI: 1.10-2.12].

Healthy Weight

From 2009-2013, the overall prevalence of healthy weight was 43.0%. The prevalence of this indicator varied by maternal characteristics. Specifically, 50.3% of NH White mothers and 53.0% NH Other such as Asian or Native American, compared to 29.8% of Hispanic mothers, had a healthy weight. Additionally, significantly higher proportions of having a healthy weight were observed among mothers who were 20 years of age or younger (55.4%), had health insurance before pregnancy (45.9%), used private insurance as payment for delivery (49.5%), and had a medical risk factor such as pre-pregnancy or gestational hypertension or diabetes, a previous preterm birth, vaginal bleeding, or previous adverse pregnancy outcomes (45.0%). When assessing healthy weight by significant maternal characteristics, decreased odds of healthy weight were observed among mothers who were NH Black [OR=0.58; 95% CI: 0.47-0.71] or Hispanic [OR=0.42; 95% CI: 0.32-0.55], unmarried [OR=0. 38; 95% CI: 0.70-0.98], did not graduate college [OR=0.63; 95% CI: 0.52-0.77], had no health insurance before pregnancy [OR=0.74; 95% CI: 0.61-0.88], and used Medicaid as payment for delivery [OR = 0.68; 95% CI: 0.56-0.82]. Increased odds of healthy weight were observed among mothers who were less than 20 years of age [OR=1.68; 95% CI: 1.30-2.16] and had a medical risk factor [OR=1.99; 95% CI: 1.51-2.61].

Avoidance of Sexually Transmitted Infections

From 2009-2013, the overall prevalence of avoidance of STIs was 10.9%. The prevalence of this indicator did not vary much by maternal characteristics. The only variations observed were by maternal age and marital status. Significantly higher proportions of STIs were observed among mothers who were 30 years of age or older (98.8%) and married (99.0%). When assessing avoidance of STI by significant maternal characteristics, decreased odds of STI avoidance were observed among mothers who were less than 20 years of age [OR=0.44; 95% CI: 0.26-0.76], NH Black [OR=0.31; 95% CI: 0.17-0.55], unmarried [OR=0.17; 95% CI: 0.09-0.31], did not graduate college [OR=0.23; 95% CI: 0.09-0.59], and used Medicaid as payment for delivery [OR = 0.19; 95% CI: 0.08-0.42]. Increased odds of STI avoidance were observed among mothers who were 30 years of age or older [OR=3.01; 95% CI: 1.39-6.48].

Diabetes Screening/Treatment

From 2009-2013, the overall prevalence of diabetes screening/treatment was 10.9%. The prevalence of this indicator varied by maternal characteristics. Specifically, 15.7% of NH Black mothers, compared to 8.1% of NH White mothers, had a diabetes screening/treatment. Additionally, significantly higher proportions of having a diabetes screening/treatment were observed among mothers resided in an urban county (11.5%) and had health insurance before pregnancy (12.7%). When assessing diabetes screening/treatment by significant maternal characteristics, increased odds of diabetes screening/treatment were observed among mothers who were less than 20 years of age [OR=1.53; 95% CI: 1.01-2.32] or 30 years of age or older [OR=1.55; 95% CI: 1.17-2.08], NH Black [OR=2.12; 95% CI: 1.56-2.88], and unmarried [OR=1.45; 95% CI: 1.10-1.90]. Decreased odds of diabetes screening/treatment were observed among mothers who had no health insurance before pregnancy [OR=0.60; 95% CI: 0.44-0.82] and had a medical risk factor [OR = 0.65; 95% CI: 0.45-0.95].

Teratogen Avoidance in Chronic Conditions

From 2009-2013, the overall prevalence of teratogen avoidance was 87.9%. The prevalence of this indicator varied by maternal characteristics. Specifically, 94.0% of mothers 20 years of age or less, compared to 82.5% of mothers 30 years of age or older, avoided teratogens. Additionally, significantly higher proportions of teratogen avoidance were observed among mothers had less than a high school education (93.7%), not married (91.4%), had health insurance before pregnancy (94.0%), used private insurance as payment for delivery (92.1%), and had a medical risk factor such as pre-pregnancy or gestational hypertension or diabetes, a previous preterm birth, vaginal bleeding, or previous adverse pregnancy outcomes (88.7%). When assessing teratogen avoidance by significant maternal characteristics, increased odds of teratogen avoidance were observed among mothers who were less than 20 years of age [OR=1.72; 95% CI: 1.12-2.65], NH Black [OR=2.17; 95% CI: 1.59-2.95], Hispanic [OR=2.99; 95% CI: 1.83-4.89] or NH Other [OR=1.97; 95% CI: 1.09-3.54], unmarried [OR=1.92; 95% CI: 1.46-2.52], did not graduate college [OR=2.38; 95% CI: 1.82-3.10], had no health insurance before pregnancy [OR=2.92; 95% CI: 2.10-4.08], used Medicaid as payment for delivery [OR = 2.47; 95% CI: 1.84-3.32], and had a medical risk factor [OR=1.76; 95% CI: 1.26-2.47]. Decreased odds of teratogen avoidance were observed among mothers who were 30 years of age or older [OR=0.52; 95% CI: 0.39-0.67].

Discussion

The purpose of this study was to apply the Clinical Workgroup's[10] conceptualization of preconception wellness to examine the distribution of preconception wellness among Georgia mothers participating in Georgia PRAMS. Based on this study, we deem it feasible to apply this conceptualization to Georgia PRAMS data given that all PCW indicators were captured in the Georgia PRAMS survey or available via birth certificate data. The majority of Georgia mothers experienced each PCW indicator except intending for their pregnancy (49.2%), having a healthy prepregnancy weight (43.0%), folic acid use (37.8%), diabetes screening/treatment (10.9%), and depression screening/treatment (7.7%). These findings were similar to previous research evaluating preconception and interconception health among 26 PRAMS sites[13,14].

Specifically in our study, mothers who experienced the majority of PCW indicators (7 to 9) were non-Hispanic (NH) White or NH Other such as Asian or Native American, 30 years of age or older, Married, resided in an urban county, had health insurance before pregnancy, and used private insurance to pay for their delivery. These findings correspond with Robbins and colleagues[15] conclusion in the first descriptive state-level summary of preconception health indicators using PRAMS and the behavioral risk factor surveillance system (BRFSS) regarding disparities among certain age and racial/ethnic groups. Compared with younger women (< 20 years), older women (≥ 30 years) frequently had a significantly higher prevalence of the following protective factors: pregnancy intention, access to care, folic acid use, tobacco avoidance, and avoidance of sexually transmitted infections. Older women tended to have significantly lower rates of healthy prepregnancy weight and teratogen avoidance in chronic conditions. All but three indicators (intended pregnancy, depression screening/treatment, and avoidance of sexually transmitted infections) were significantly different by race/ethnicity. Compared with women of other racial/ethnic groups, non-Hispanic White women had significantly higher rates of access to care and folic acid use. Non-Hispanic Black women had significantly higher rates of diabetes screening/treatment compared to any other racial/ethnic group.

Our study also found significant disparities by maternal education, marital status, health insurance before pregnancy, and payment for delivery. Mothers who are college graduates, married, had health insurance before pregnancy, and used private insurance to pay for their delivery had significantly higher rates of experiencing at least four of the nine preconception wellness indicators. These findings emphasize the need for targeted programs that address the varying health disparities. Robbins and colleagues[15] advise the integration of preconception health care into existing public health services given the well-established evidence supporting that these interventions improve a woman's preconception health (e.g. smoking cessation, glucose control, etc.) and ultimately improve pregnancy outcomes[16-18].

Although using Georgia PRAMS surveillance data to track and monitor preconception wellness was sufficient, there are suggested improvements to increase the strength of its feasibility. First, neither the birth certificate nor the Georgia PRAMS survey inquired about STI *before* pregnancy. For this study, STI *during* pregnancy was used as a proxy to preconception exposure. However, we recommend a revision to the next phase of the Georgia PRAMS questionnaire to include a specific question on STI exposure prior to conception. Second, throughout the study period (2009-2013) there were Georgia PRAMS questions regarding diabetes and depression screening; however, questions regarding the presence of diabetes or depression were not available until 2012. As Georgia collects more data on the presence of diabetes and depression, these questions should be used in future analyses. Third, although research suggests that approximately 10-15% of congenital anomalies are due to teratogenic maternal exposures to medications, alcohol, or other exogenous factors that have adverse effects on a developing embryo or fetus, having women have no teratogenic medications since their last menstrual period may not be feasible depending on the chronic condition[10,19]. A growing number of reproductive aged women are treated for chronic disease[20]. Recent studies found that in the first trimester, 80% of women take at least one prescription or over-the-counter medication[21]. With optimal preconception care, women treated with teratogenic medications would discuss pregnancy intentions with their health care providers. Furthermore, health care providers would ensure women planning to conceive are counseled on the risks and benefits of potential alternative treatment regimens[10].

Applying these recommended edits, Georgia PRAMS can be the ideal state surveillance system to describe preconception wellness. Understanding that multiple healthcare providers, clinics, and public health programs deliver preconception care to reproductive aged women, these findings provide Georgia public health professionals with a baseline for where Georgia mothers stand regarding preconception wellness and provide an opportunity to monitor changes in preconception wellness over time. This study assessed preconception wellness via surveillance data to ultimately aid in the development of evidence-based guidelines that are incorporated into health practice and population health outcomes[22]. These findings also aid public health key stakeholders in making state and national comparisons that can be used for needs assessments, resource allocation, and program evaluation.

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Table 4.1. Georgia Pregnancy Risk Assessment Monitoring System (PRAMS) Preconception Wellness (PCW) Indicators[1] Reclassified

PCW Indicator	PRAMS Survey Question	Available Answer Choice	Reclassified Response
Pregnancy intention	Thinking back to just before you got pregnant with your new baby, how did you feed about becoming pregnant?	☐ I wanted to be pregnant later ☐ I wanted to be pregnant sooner ☐ I wanted to be pregnant then ☐ I didn't want to be pregnant then or at any time in the future ☐ I wasn't sure what I wanted	☐ Yes: I wanted to be pregnant then ☐ No: All other answer choices
Access to care	How many weeks or months pregnant were you when you had your first visit for prenatal care?	___Weeks or ___Months	☐ Yes: Within 1st Trimester ☐ No: Not within 1st Trimester
Folic acid use	During the month before you got pregnant with your new baby, how many times a week did you take a multivitamin, a prenatal vitamin, or folic acid vitamin?	☐ I didn't take a multivitamin, prenatal vitamin, or folic acid vitamin the *month before* I got pregnant ☐ 1 to 3 times a week ☐ 4 to 6 times a week ☐ Every day of the week	☐ Yes: took a multivitamin at least once per week ☐ No: Didn't take a multivitamin
Tobacco avoidance	Have you smoked any cigarettes in the past 2 years?	☐ Yes ☐ No	---
Depression screening/treatment	During the 12 months before you got pregnant with your new baby, did you visit a health care worker to be checked or treated for depression or anxiety?	☐ Yes ☐ No	---
Healthy weight	How tall are you without shoes? & Just before you got pregnant with your new baby, how much did you weigh?	___Feet ___Inches ___Pounds ___Kilos	Calculated body mass index (BMI) ☐ Yes: Normal BMI (18.5-24) ☐ No: All other BMI levels
Sexually transmitted infection (STI) presence/treatment	*STI present/treated during pregnancy was ascertained from the birth certificate*	☐ Chlamydia ☐ Gonorrhea ☐ Hepatitis B ☐ Hepatitis C ☐ Syphilis	☐ Yes: at least 1 STI present/treated during pregnancy ☐ No: No STIs present/treated during pregnancy
Diabetes screening/treatment	During the 12 months before you got pregnant with your new baby, did you visit a health care worker to be checked or treated for diabetes?	☐ Yes ☐ No	---
Teratogen avoidance in chronic conditions	During the 12 months before you got pregnant with your new baby, were you regularly taking prescription medicines other than birth control?	☐ Yes ☐ No	---

[1]Frayne DJ, Verbiest S, Chelmow D, et al. Health care system measures to advance preconception wellness: Consensus recommendations of the clinical workgroup of the national preconception health and health care initiative. Obstet Gynecol. 2016;127(5):863-872

Table 4.2. Weighted Percentages (and Confidence Intervals) of Georgia PRAMS Respondent Characteristics by Each Preconception Wellness (PCW) Indicator Experienced, 2009-2013

	Intended Pregnancy	Access to Care	Folic Acid Use	Tobacco Avoidance	Depression Screening/ Treatment	Healthy Weight	Avoidance of Sexually Transmitted Infections	Diabetes Screening/ Treatment	Teratogen Avoidance in Chronic Conditions
Overall	49.2 (47.0-51.3)	82.8 (81.1-84.4)	37.9 (35.8-40.0)	81.7 (80.0-83.3)	7.7 (6.7-8.9)	43.2 (41.1-45.3)	97.0 (96.1-97.6)	10.9 (9.6-12.3)	87.8 (86.4-89.1)
Race/Ethnicity									
White, non-Hispanic	59.0 (55.9-62.1)	90.8 (88.8-92.5)	45.9 (42.8-49.0)	73.8 (70.9-76.5)	9.5 (7.8-11.5)	50.6 (47.5-53.7)	98.2 (97.2-98.9)	8.1 (6.6-9.9)	83.0 (80.5-85.1)
Black, non-Hispanic	31.4 (28.0-34.9)	78.3 (75.0-81.2)	29.0 (25.7-32.6)	85.6 (82.7-88.1)	7.7 (6.0-9.8)	37.2 (33.6-40.8)	94.5 (92.4-96.0)	15.7 (13.2-18.7)	91.3 (89.0-93.2)
Hispanic	53.5 (47.9-59.0)	67.7 (62.1-72.8)	30.4 (25.5-35.9)	93.4 (89.9-95.8)	3.3 (1.9-5.7)	30.2 (25.3-35.5)	97.5 (95.0-98.8)	9.0 (6.3-12.8)	93.6 (90.2-95.9)
Other, non-Hispanic	56.1 (47.3-64.5)	86.2 (79.1-91.2)	44.6 (36.1-53.4)	91.5 (85.5-95.2)	4.3 (1.9-9.3)	53.1 (44.5-61.6)	97.5 (93.0-99.1)	10.8 (6.5-17.5)	90.6 (84.5-94.4)
Maternal Age									
< 20 years	23.4 (18.8-28.8)	68.2 (62.7-73.2)	18.9 (14.8-23.9)	74.9 (69.5-79.7)	8.9 (6.2-12.6)	55.2 (49.6-60.7)	92.6 (89.2-95.0)	13.1 (9.5-17.7)	94.0 (91.4-95.8)
20-29 years	44.7 (41.7-47.6)	82.1 (79.6-84.3)	31.1 (28.4-33.9)	79.0 (76.4-81.3)	6.4 (5.1-7.9)	42.4 (39.5-45.3)	96.6 (95.3-97.5)	8.9 (7.4-10.8)	90.1 (88.2-91.7)
≥ 30 years	64.1 (60.6-67.4)	88.3 (85.8-90.5)	54.0 (50.5-57.5)	88.1 (85.7-90.2)	9.4 (7.6-11.6)	41.0 (37.6-44.3)	98.8 (97.7-99.4)	13.2 (11.0-15.7)	82.4 (79.7-84.9)
Maternal Education									
< High school	38.2 (33.3-43.3)	66.7 (61.6-71.4)	23.3 (19.2-28.0)	78.5 (74.0-82.5)	7.2 (5.0-10.2)	35.6 (30.9-40.5)	93.2 (89.9-95.4)	11.3 (8.4-15.0)	93.7 (90.9-95.7)
High school Graduate	39.7 (36.0-43.6)	79.7 (76.4-82.7)	29.0 (25.6-32.7)	77.1 (73.6-80.3)	6.0 (4.5-8.0)	39.8 (36.1-43.7)	96.8 (95.1-97.9)	11.0 (8.8-13.7)	90.7 (88.1-92.7)
Some college	46.1 (41.7-50.6)	84.8 (81.2-87.8)	32.1 (28.1-36.4)	80.9 (77.1-84.2)	7.0 (5.1-9.4)	44.9 (40.5-49.3)	97.8 (96.2-98.8)	9.1 (6.8-12.1)	88.0 (84.8-90.5)
College Graduate	69.2 (65.2-72.9)	96.3 (94.3-97.5)	63.6 (59.6-67.4)	90.2 (87.4-92.4)	10.8 (8.5-13.6)	51.6 (47.5-55.6)	99.1 (97.8-99.6)	12.2 (9.8-15.1)	80.2 (76.7-83.2)
Marital Status									
Married	65.2 (62.4-67.8)	89.3 (87.3-90.9)	51.3 (48.5-54.2)	85.9 (83.8-87.7)	7.5 (6.2-9.2)	45.4 (42.6-48.2)	99.0 (98.4-99.5)	9.2 (7.7-11.0)	84.7 (82.6-86.6)
Not Married	30.9 (28.0-33.9)	75.4 (72.5-78.1)	22.5 (19.9-25.3)	77.1 (74.3-79.7)	7.9 (6.4-9.7)	40.8 (37.7-43.9)	94.5 (92.9-95.8)	12.8 (10.8-15.1)	91.4 (89.5-93.0)
Urban/Rural Status									
Urban County	51.0 (48.5-53.5)	83.6 (81.6-85.4)	40.8 (38.4-43.3)	83.6 (81.7-85.4)	7.5 (6.4-8.9)	43.9 (41.5-46.3)	97.3 (96.3-98.0)	11.4 (10.0-13.1)	87.4 (85.7-88.9)
Rural County	44.3 (40.2-48.4)	80.7 (77.1-83.8)	29.6 (26.0-33.6)	76.4 (72.7-79.8)	8.2 (6.3-10.7)	41.3 (37.3-45.4)	95.9 (93.9-97.2)	9.3 (7.1-11.9)	89.1 (86.4-91.4)
Health Insurance Before Pregnancy									
Yes	54.8 (52.1-57.4)	88.7 (86.9-90.3)	47.4 (44.8-50.0)	82.2 (80.0-84.2)	9.4 (8.0-11.1)	46.0 (43.4-48.6)	97.5 (96.6-98.2)	12.6 (10.9-14.5)	84.2 (82.2-86.0)
No	39.7 (36.3-43.3)	72.6 (69.2-75.7)	21.5 (18.7-24.6)	81.1 (78.1-83.7)	4.9 (3.6-6.6)	38.5 (35.1-42.0)	96.1 (94.4-97.3)	7.9 (6.2-10.1)	94.0 (92.0-95.5)
Payment for Delivery									
Private Insurance	68.6 (65.1-71.8)	96.0 (94.4-97.1)	57.0 (53.4-60.5)	87.8 (85.2-90.0)	8.3 (6.6-10.4)	49.8 (46.2-53.3)	99.0 (98.0-99.6)	10.5 (8.5-12.8)	82.4 (79.5-84.9)
Medicaid	33.0 (30.0-35.0)	76.5 (73.6-79.1)	23.7 (21.2-26.7)	74.3 (71.3-77.1)	7.9 (6.4-9.8)	40.1 (37.0-43.3)	95.1 (93.5-96.3)	11.0 (9.1-13.2)	92.0 (90.1-93.6)
Other	52.7 (46.9-58.4)	74.1 (68.6-79.0)	33.3 (28.1-39.0)	86.5 (82.1-90.0)	6.1 (4.1-9.1)	38.1 (32.8-43.8)	97.1 (94.4-98.6)	10.9 (7.8-15.2)	88.3 (84.1-91.4)
Medical Risk Factor									
Yes	49.3 (46.9-51.6)	82.7 (80.8-84.4)	37.9 (35.7-40.2)	81.8 (79.9-83.6)	7.4 (6.3-8.7)	45.3 (43.0-47.6)	97.1 (96.3-97.8)	10.0 (8.7-11.5)	88.7 (87.1-90.0)
No	52.3 (46.1-58.2)	85.1 (80.2-88.9)	37.3 (31.8-43.2)	81.4 (76.2-85.7)	8.7 (6.0-12.5)	29.4 (24.4-35.0)	96.4 (93.2-98.1)	14.5 (10.8-19.3)	81.6 (76.6-85.8)

Note: PRAMS: Pregnancy Risk Assessment Monitoring System; Medical Risk Factor includes pre-pregnancy or gestational hypertension or diabetes, a previous preterm birth, vaginal bleeding, or previous adverse pregnancy outcomes.

CHAPTER 5

EXAMINING THE ASSOCIATION BETWEEN PRETERM BIRTH AND PRECONCEPTION WELLNESS AMONG GEORGIA MOTHERS[2]

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[2] Kanu FA, Salm Ward TC, Shen Y, Miles T, and Cordero JF. To be submitted to *Journal of Women's Health*.

Abstract

<u>Background</u>**:** During the past decade, the slight decline in adverse birth outcomes despite improvements in prenatal care suggests that prenatal care alone is not sufficient to ensure positive pregnancy outcomes. The purpose of this paper is to examine the association between the nine preconception wellness indicators as defined by the Clinical Workgroup and preterm birth (PTB) among Georgia mothers using the Georgia Pregnancy Risk Assessment Monitoring System (PRAMS).

<u>Methods</u>**:** Data were collected during 2009-2013 in the Georgia Pregnancy Risk Assessment Monitoring System (PRAMS), a state specific population-based surveillance system that collects data on select maternal behaviors and experiences occurring before, during, and shortly after pregnancy. Preconception wellness indicators experienced per mom were summed and categorized as 1-3, 4-6, and 7-9 for analysis. PTB was defined as any live birth between 20 and 36 completed weeks' gestation or fewer than 259 days determined by obstetric estimate of gestation at delivery. Descriptive statistics, bivariate analyses, and logistic regression models assessed the experience of preconception wellness individually and cumulatively by PTB.

<u>Results</u>**:** The sample was representative of the population of healthy women in Georgia. The majority (74.5%) experienced 4 to 6 preconception wellness indicators at least one month before they became pregnant with their new baby. Experiences of PCW indicators ranged from 7.4% (depression screening/treatment) to 96.9% (absence of STI). About 9% of mothers delivered an infant who was less than 37 weeks'

gestation. The logistic regression models examining the effects of each PCW indicator showed that after controlling for significant maternal characteristics, depression and diabetes screening/treatment was significantly associated with increased odds of PTB and teratogen avoidance was significantly associated with decreased odds of PTB. As the number of cumulative PCW indicators increased, the odds of PTB decreased; however, this decreases in odds were not statistically significant.

Conclusion**:** This study did not find a significant association between increased preconception wellness indicators and decreased odds of preterm birth. Though our results did not support our hypothesis, given PRAMS' standardized methodology this study can be replicated within other PRAMS sites to aid in the prioritization of preconception wellness in the United States.

Key words**:** preconception wellness, PRAMS, preterm birth, pregnancy

Introduction

The purpose of preconception care is to identify and modify biomedical, behavioral, and social risks to a woman's health or pregnancy outcome through prevention and management strategies[1,2]. Caring for a pregnancy should happen before conception and preconception care should occur at every visit a health care provider has with a woman of reproductive age[1]. Preconception care provides an opportunity to optimize the health of a woman independent of whether she becomes pregnant[3]. The preconception period is a critical time given that several risk behaviors and exposures during this time can negatively affect fetal development and subsequent outcomes. Oftentimes these behaviors co-occur, compounding the risk for adverse birth outcomes such as preterm birth.

During the past decade, the slight decline in adverse birth outcomes despite improvements in prenatal care suggests that prenatal care alone is not sufficient to ensure positive pregnancy outcomes[4-7]. The Clinical Workgroup of the CDC Preconception Health and Healthcare (PCHHC) Initiative proposed nine preconception wellness measures to track the quality of care provided prior to conception[8]. This workgroup defines preconception wellness as a woman's level of well-being at the time of conception as influenced by her clinical and psychosocial status and environment at any point in time[8].

The purpose of this paper is to examine the association between the nine preconception wellness indicators as defined by the Clinical Workgroup and preterm birth among Georgia mothers using the Georgia Pregnancy Risk Assessment Monitoring System (PRAMS). To date, no study has utilized one data source to comprehensively describe preconception wellness and its relation to preterm birth at the state level. Understanding the distribution of preconception wellness and its association with preterm birth can allow for targeted interventions to address the slightly increasing rate of preterm birth in the state.

Methods

<u>Data Source</u>

Georgia Pregnancy Risk Assessment Monitoring System (PRAMS) data from 2009-2013 were obtained from the Georgia Department of Public Health. PRAMS is a multi-state, population-based surveillance system conducted by states in collaboration with the Centers for Disease Control and Prevention (CDC). PRAMS was designed to supplement vital records data on selected maternal behaviors and experiences that occurred before, during, and after pregnancy[9]. Questionnaires were mailed to sampled women within two to six months post-delivery, and follow-up attempts to collect data via phone were made for mail non-responders[10]. Georgia PRAMS collects information on women who deliver live infants in Georgia to improve the health of Georgia's mothers and babies.

<u>Study Participants</u>

Each month, the Georgia Department of Public Health draws a systematically random sample of approximately 100-200 women from Georgia's birth certificate registry. PRAMS data were weighted by CDC to ensure that the sample drawn by the Georgia Department of Public Health was representative of all women who had a live birth in Georgia. Between 2009 and 2013, 8,325 women were invited to participate in

Georgia PRAMS and 5,453 completed the survey. The survey response rate for each year met the CDC threshold of 65%, ranging from 65.2% to 66.1% with an overall unweighted response rate of 65.5%. This research was reviewed and approved by the Georgia Department of Public Health and the University of Georgia Institutional Review Boards.

<u>Preconception Wellness Indicators</u>

Preconception wellness (PCW) indicators were summarized in Table 1 and based on nine questions about events that may have occurred at least 1 month before the new baby was conceived. These indicators were adapted from the Clinical Workgroup of the CDC Preconception Health and Healthcare Initiative[8]. In this analysis, PCW indicators were analyzed using 2 distinct methods. First, the impact of each individual PCW indicator was examined. Second, a cumulative PCW count was calculated by adding the number of PCW indicators each participant reported experiencing to create a composite score ranging from 0 (no PCW indicators experienced) to 9 (all PCW indicators experienced). All PCW indicators were reclassified as dichotomous variables comparing the desired behavior to the undesired behavior.

<u>Preterm Birth</u>

Gestational age at birth ascertained from the birth certificate was used to determine the pregnancy outcome of interest in this study. Preterm birth (PTB) was defined as any live birth between 20 and 36 completed weeks' gestation or fewer than 259 days determined by obstetric estimate of gestation at delivery (OE). While last menstrual period (LMP) has been widely used clinically in the past, OE was introduced in 2003 as the best estimate of an infant's gestation in completed weeks based on the birth attendant's final estimate of gestation[11,12]. Data including the OE estimate in lieu of the date of a mother's LMP have been included in the National Vital Statistics System since 2007 and has been thought to improve monitoring of gestational age trends, identification of population disparities in PTB, mortality risk estimation by gestational age and understanding of the etiology of PTB[11].

Maternal Characteristics

For this analysis, maternal age was categorized as less than 20 years of age, 20-29 years of age, and 30 years of age or older. Maternal race/ethnicity was classified as either Hispanic or non-Hispanic (NH), and non-Hispanic was categorized as NH White, NH Black, or NH Other (e.g., Asian, Native American, mixed race). Maternal education was categorized as less than high school, high school graduate, some college, and college graduate. Marital status was categorized as married or unmarried at the time of conception or birth. Payment for delivery was used as a proxy for socioeconomic status and categorized as private insurance, Medicaid, or other (e.g., self-pay, Tricare, etc.). Urban/Rural status was determined by the urban/rural status of the county where participants resided at time of delivery. Medical risk factor was designated as yes/no where medical risk factor was coded 'yes' if a participant had pre-pregnancy or gestational hypertension or diabetes, a previous preterm birth, vaginal bleeding, or previous adverse pregnancy outcomes.

All PCW indicators except absence of sexually transmitted infection (STI) were ascertained from the Georgia PRAMS questionnaire. The remaining variables were ascertained from Georgia birth certificate data, including maternal race/ethnicity, age, education, marital status, payment for delivery, urban/rural status, medical risk factor, and STI presence/treatment during pregnancy.

<u>Statistical Analysis</u>

Rao-Scott chi-square tests for weighted data were performed to detect statistical differences ($p<0.05$) between PCW indicators and PTB. To assess experiences of each PCW indicator and its association with PTB, logistic regression models accounting for varying covariate adjustment levels were run. Because of the potential co-occurrence of PCW indicators, other specific PCW indicators were added as covariates to evaluate each PCW indicator's independent effect. To assess experiences of the cumulative number of PCW indicators and PTB, weighted logistic regression models were performed with and without adjusting for significant covariates and confounders such as maternal characteristics and pregnancy complications.

Variables were evaluated for potential confounding using a two-stage process. First, univariable unconditional logistic regression models for weighted data were evaluated for each independent variable. Variables were considered for inclusion at $p<0.20$ and were then included as covariates in a multivariable statistical model. Variables were selected for inclusion in the final model using manual forward selection. Variables were retained if their addition to the full model resulted in a significant difference ($p<0.05$) in the -2 log likelihood of the full and reduced models or based on *a priori* knowledge.

Odds ratios (OR) and their corresponding 95% confidence intervals (CI) were presented. Associations were considered statistically significant if the CI for the corresponding OR did not include 1. SAS 9.4 (SAS Institute, Cary, NC) and SAS-Callable SUDAAN 11.0.1 (Research Triangle Institute, Research Triangle Park, NC) were utilized to account for the complex survey weights and to conduct all statistical analyses. Figure 5.1 illustrates the inclusion and exclusion flow chart for analysis. Participants were excluded from analysis if 1) they did not respond to the Georgia PRAMS questionnaire (N = 2,872), 2) if they delivered a non-singleton infant (e.g., twins, triplets, etc.) or if plurality was missing (N = 261), and 3) if gestational age was less than 20 weeks (N=35).

Results

Participant Characteristics

A total of 5,453 women responded to the Georgia PRAMS survey from 2009-2013. After excluding 261 participants who did not have singleton births and 35 with less than 20 weeks' gestation, 5,157 remained for analysis. Characteristics of the study sample are described in Table 2. Our sample contained a substantial proportion of women with one or more characteristics associated with adverse birth outcomes. These include NH Black race/ethnicity (31.7%), maternal age < 20 (10.6%) or >35 (12.6%), less than high school education (18.8%), unmarried (46.8%), Medicaid as payment for delivery (48.0%), and medical risk factor such as pre-pregnancy or gestational hypertension, pre-pregnancy or gestational diabetes, a previous preterm birth, vaginal bleeding, or previous adverse pregnancy outcomes (12.1%).

The sample was representative of the population of healthy women in Georgia. The majority (74.5%) experienced 4 to 6 preconception wellness indicators at least one month before they became pregnant with their new baby. Experiences of PCW indicators ranged from 7.4% (depression screening/treatment) to 96.9% (absence of STI). About 9% of mothers delivered an infant who was less than 37 weeks' gestation. When the distributions of characteristics were examined by PTB (Table 2), women who were NH Black, unmarried, Medicaid insured, experienced a medical risk factor, and did not have a prenatal care visit within their 1st trimester (access to care) had significantly higher rates of PTB compared to women who did not experience PTB.

Specific PCW Indicators

Results of the logistic regression models examining the effects of each PCW indicator showed that in the unadjusted models, prenatal care visit within the 1st trimester (access to care) was significantly associated with decreased odds of PTB and depression and diabetes screening/treatment were significantly associated with increased odds of PTB (Table 3). After controlling for significant maternal characteristics, depression and diabetes screening/treatment remained significantly associated with increased odds of PTB and teratogen avoidance was significantly associated with decreased odds of PTB. After controlling for other reported PCW indicators, none of the indicators significantly predicted the odds of PTB. Estimates among PCW indicators were calculated to assess multicollinearity for the specific PCW indicator logistic regression. PCW indicators were not highly correlated given that the variance-inflation factor ranged from 1.01-1.14 and tolerance ranged from 0.88-0.99.

Cumulative Preconception Wellness Indicators

Results for the weighted cumulative PCW indicator logistic regression model for prediction of PTB is presented in Table 4. Significantly higher odds of PTB were identified among mothers who were NH Black (compared to NH White, OR = 1.53 [95% CI: 1.08-2.17]), NH Other (compared to NH White, OR = 1.89 [95% CI: 1.05-3.04]), unmarried (compared to married, OR = 1.55 [95% CI: 1.06-2.27]), and had a medical risk factor (compared to no medical risk factor, OR = 2.87 [95% CI: 2.07-3.97]). After controlling for race/ethnicity, payment for delivery, marital status, and medical risk factor, women who experienced 4 to 6 PCW indicators had a 33% decreased odds of PTB and women who experienced 7 to 9 PCW indicators had a 59% decreased odds of PTB compared to those who only experienced 1 to 3 PCW indicators. However, these decreases in odds were not statistically significant (OR: 0.67 [95% CI: 0.35-1.27]; OR: 0.41 [0.14, 1.22]).

Discussion

The purpose of this study was to apply the Clinical Workgroup's[8] conceptualization of preconception wellness (PCW) to examine the association between preconception wellness indicators and preterm birth among Georgia mothers. About 9% of our analysis sample experienced PTB, which falls within the range of PTB across the nation from 2009-2013 (7.6% to 13.6%)[11]. In Georgia, more than half of mothers experience each PCW indicator except intending for their pregnancy (49.2%), having a healthy prepregnancy weight (43.0%), and folic acid use (37.8%). These findings were similar to previous research evaluating preconception and interconception health among 26 PRAMS sites[2,13].

When we examined the effect of individual PCW indicators on the odds of PTB, we found that depression screening/treatment and teratogen avoidance significantly decreased the odds of PTB. These findings coincide with previous literature concluding that prepregnancy depression and prenatal antidepressant use was associated with lower gestational age at birth and an increased risk of PTB [14-17]. Being able to see a provider can contribute to one's likelihood of taking anti-depression medication or a teratogen for chronic conditions (like diabetes or hypertension). However, women who work low wage jobs without adequate health insurance benefits may be less likely to take these medications whether they have the disorders or not due to their limited access to care.

When controlling for significant maternal characteristics and all other PCW indicators, none of the PCW indicators remained significantly associated with PTB. The multicollinearity analysis determined that the PCW indicators were not highly correlated, which was opposite of what we anticipated. One explanation for this finding could be that controlling for all PCW indicators may have resulted in an over adjustment of the relationship between each PCW indicator and PTB. This may suggest that one PCW indicator is more influential than the other regarding its association with PTB.

In our cumulative PCW indicator logistic regression model, we found that as the number of PCW indicators increased, the odds of PTB did not significantly decrease after adjusting for significant maternal characteristics. This finding was not consistent with previous literature that found PTB was less common among women who had preconception care[18]. One potential reason for our inconsistent finding could be that Georgia PRAMS preconception questions do not ask about preconception wellness within the same timeframe. Some questions do not specify a timeframe while others state 'one month before pregnancy' or 'during the 12 months before pregnancy'. We suggest rephrasing the questions to ask about participant's behavior at least 12 to 24 months before pregnancy. This may allow for a better conceptualization of a woman's health before she becomes pregnant.

Specifically in our study, women who were NH Black, unmarried, used Medicaid insurance as payment for delivery, and had any medical risk factors had increased rates of having a preterm infant. Giscombé and Lobel[19] reviewed the literature to identify contributors to the disproportionately high rates of adverse birth outcomes among NH Black women and found that behavioral and sociodemographic factors do not fully account for the disparities. They note that failure to examine racism among Black women, distinct from other forms of prenatal stress, is a serious oversight given the research suggesting that racism heightens allostatic load or cumulative burden of Black women and can negatively impact their pregnancy outcomes[19,20]. Georgia PRAMS did not inquire about racial discrimination from 2009-2013 but the current version of the survey (Phase 8) asks women if they felt emotionally upset 12 months before the birth of their new baby as a result of how they were treated based on their race[21].

Previous literature suggests that marital status is associated with a lower risk of PTB due to increased financial security, health care access, social support, and mental health of married vs. unmarried mothers[22-25]. However, the perception of marriage in the US has changed over the years, with a change in marital norms that shape partners' social behaviors[26,27]. With cohabitation growing in social acceptability and preference for young US adults, El-Sayed and Galeo[25] argued that cohabiting mothers may experience levels of financial and emotional support greater than non-cohabiting unmarried counterparts but lower than their married counterparts due to the formation of joint households. This means that marital status alone should not be solely used as a proxy measure for social, financial or emotional support. It is suggested that the conception of metrics for social determinants of health (e.g., marital status vs. cohabitation status) be changed to accommodate the shift in marital norms in the US. This will allow for a more accurate measure of association between marital/cohabitation status and PTB.

Among all PTB from 2010-2013, Medicaid covered a significantly higher percentage of those births compared to private insurance (48.8% vs. 42.1%; $p < .001$) and after controlling for relevant covariates that contribute to PTB, a birth was more likely to be preterm if the mother was covered by Medicaid compared to mothers covered by private insurance[28]. Additionally, many risk factors known to be associated with PTB are more prevalent among Medicaid-covered women compared to women with private insurance, including younger age, unmarried status, Black race or Hispanic ethnicity, and education less than a high school degree[28]. The risk of PTB due to health insurance (Medicaid vs. non-Medicaid) may also be associated with the delay in prenatal care among pregnant women with Medicaid[29]. Pregnancy is one of the eligibility criteria for Medicaid coverage. Therefore, a mother does not receive Medicaid coverage until she is confirmed to be pregnant. Because of this, she does not receive the preconception care needed to ensure she is at her optimal health before entering pregnancy. The Affordable Care Act (ACA) Medicaid expansion was designed to address the high uninsured rates among adults living below poverty. Although 32 states (including DC) adopted the Medicaid Expansion as of January 2017, Georgia was not one of them[30]. As a result, women and families who are within the coverage gap (e.g., those employed either part-time or full-time but still living below the poverty line[31]) are unable to receive the necessary preconception care despite their pregnancy status.

Limitations

There are limitations to this study that may hinder the ability to apply these findings to all Georgia women. Georgia PRAMS is not representative of all pregnancies; women who had an abortion or experienced a fetal death (miscarriage or stillbirth) were not represented in this analysis. Women who experience an abortion or fetal death may experience different risk factors than women whose pregnancy resulted in a live birth[32-34]. Since data were collected via mail and telephone, there is the potential for non-coverage and non-response bias. However, Georgia PRAMS data are weighted by CDC to adjust for sampling probabilities, non-response, and non-coverage; therefore, the potential for non-coverage and non-response bias were minimized[35].

Respondents were asked to complete the questionnaire between 2 and 9 months postpartum, when preconception recall may have declined. Additionally, recall bias related to experience of PCW indicators or reclassifying the PCW indicators may have introduced differential misclassification. That is, women without a PCW experience could have been misclassified as experiencing the PCW indicator or vice versa. Differential misclassification is non-random and can result in an erroneous effect estimate. Since differential misclassification cannot be corrected using statistical methods, we suggest a revision to the next phase of the Georgia PRAMS questionnaire to accurately measure each PCW indicator as recommended by the Clinical Workgroup of the CDC Preconception Health and Healthcare Initiative. A revision is also warranted since neither the birth certificate nor Georgia PRAMS inquired about the presence of a sexually transmitted infection (STI) *before* pregnancy but rather presence/treatment of STI *during* pregnancy. Furthermore, a growing number of reproductive aged women are treated for chronic disease[36]. Recent studies found that in the first trimester, 80% of women take at least one prescription or over-the-counter medication[37]. The revision should also include questions inquiring about prescribed and over-the-counter medications taken before pregnancy to help determine which were teratogenic and compliance with taking these medications as noncompliance could have negative implications for preconception wellness. These revisions will allow for accurate monitoring of preconception wellness in Georgia.

In spite of these limitations, PRAMS remains a unique source and essential for monitoring maternal and child health indicators at the state level. PRAMS utilizes a standardized data collection methodology, allowing for comparison across other participating PRAMS sites. Furthermore, PRAMS is an anonymous survey. Its anonymity decreases the potential for reporting bias due to fear of stigmatization. Lastly, the overall response rate to Georgia PRAMS was relatively high from 2009-2013 (approximately 66%), minimizing the probability of non-response and non-coverage bias.

Implications for Practice

We hypothesized that the more cumulative PCW indicators a woman experienced the lower her odds of experiencing a preterm birth, however, our study did not find a significant association between increased preconception wellness indicators and decreased odds of preterm birth. This research addressed the need for preconception wellness (PCW) among Georgia mothers and ultimately promotes community engagement to ensure women are at an optimal health status when entering pregnancy. Preconception care must be integrated into health care systems at all points of entry and occur during every health care provider visit to ensure a significant paradigm shift in the PCW of women of reproductive age. Though there has been progress in policy, consumer outreach and message development, public health programming, and clinician education[38], there has been a lag in clinical implementation. Frayne and colleagues[8] believed the delay in implementation is attributable to a lack of consensus on quality measures of preconception care. Clinical providers have the evidence needed to guide preconception care, yet this care is not always provided or documented in a way that will achieve desired outcomes[8]. This study assessed PCW via surveillance data to ultimately aid in the development of evidence-based guidelines that are incorporated into health practice and population health outcomes[39].

Conclusion

This study concludes that it is feasible to apply Clinical Workgroup's[8] conceptualization of preconception wellness (PCW) to state level surveillance data such as Georgia PRAMS. In applying this methodology, we examined the association between preconception wellness and preterm birth among Georgia mothers. This research provides additional support for the use of the established quality metrics for preconception wellness by Frayne and colleagues[8]. Though our results did not support our hypothesis, given PRAMS' standardized methodology this study can be replicated within other PRAMS sites to aid in the prioritization of preconception wellness in the United States.

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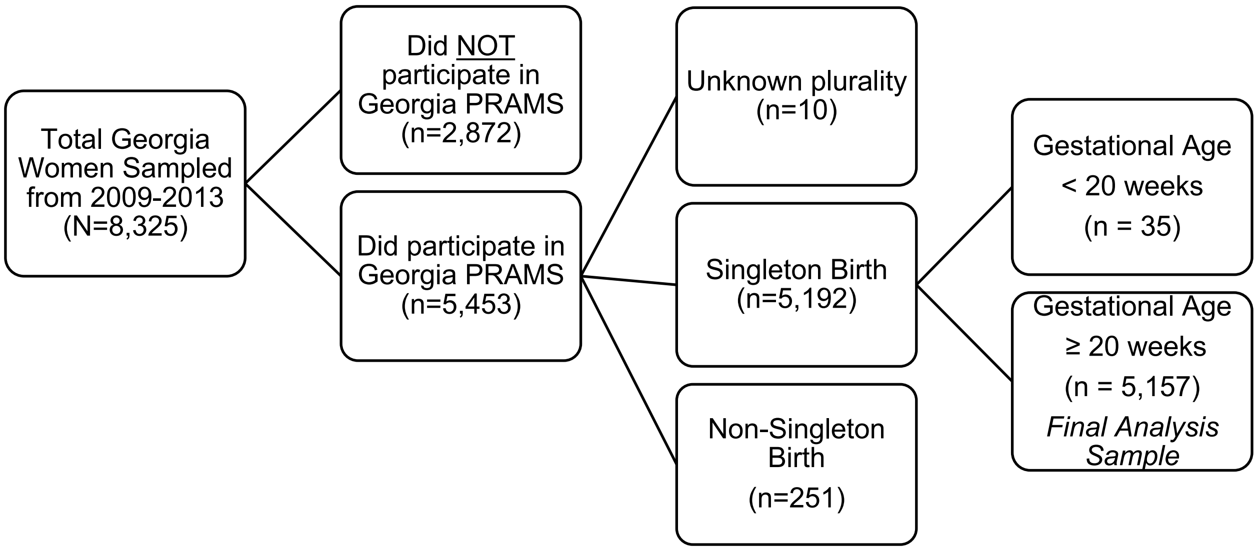
Figure 5.1. Study Sample Inclusion/Exclusion Flowchart, Georgia Pregnancy Risk Assessment 2009-2013



PRAMS: Pregnancy Risk Assessment Monitoring System

Table 5.1. Georgia Pregnancy Risk Assessment Monitoring System (PRAMS) Preconception Wellness (PCW) Indicators[1] Reclassified

PCW Indicator	PRAMS Survey Question	Available Answer Choice	Reclassified Response
Pregnancy intention	Thinking back to just before you got pregnant with your new baby, how did you feed about becoming pregnant?	☐ I wanted to be pregnant later ☐ I wanted to be pregnant sooner ☐ I wanted to be pregnant then ☐ I didn't want to be pregnant then or at any time in the future ☐ I wasn't sure what I wanted	☐ Yes: I wanted to be pregnant then ☐ No: All other answer choices
Access to care	How many weeks or months pregnant were you when you had your first visit for prenatal care?	___Weeks or ___Months	☐ Yes: Within 1st Trimester ☐ No: Not within 1st Trimester
Folic acid use	During the month before you got pregnant with your new baby, how many times a week did you take a multivitamin, a prenatal vitamin, or folic acid vitamin?	☐ I didn't take a multivitamin, prenatal vitamin, or folic acid vitamin the *month before* I got pregnant ☐ 1 to 3 times a week ☐ 4 to 6 times a week ☐ Every day of the week	☐ Yes: took a multivitamin at least once per week ☐ No: Didn't take a multivitamin
Tobacco avoidance	Have you smoked any cigarettes in the past 2 years?	☐ Yes ☐ No	---
Depression screening/treatment	During the 12 months before you got pregnant with your new baby, did you visit a health care worker to be checked or treated for depression or anxiety?	☐ Yes ☐ No	---
Healthy weight	How tall are you without shoes? & Just before you got pregnant with your new baby, how much did you weigh?	___Feet ___Inches ___Pounds ___Kilos	Calculated body mass index (BMI) ☐ Yes: Normal BMI (18.5-24) ☐ No: All other BMI levels
Sexually transmitted infection (STI) presence/treatment	*STI present/treated during pregnancy was ascertained from the birth certificate*	☐ Chlamydia ☐ Gonorrhea ☐ Hepatitis B ☐ Hepatitis C ☐ Syphilis	☐ Yes: at least 1 STI present/treated during pregnancy ☐ No: No STIs present/treated during pregnancy
Diabetes screening/treatment	During the 12 months before you got pregnant with your new baby, did you visit a health care worker to be checked or treated for diabetes?	☐ Yes ☐ No	---
Teratogen avoidance in chronic conditions	During the 12 months before you got pregnant with your new baby, were you regularly taking prescription medicines other than birth control?	☐ Yes ☐ No	---

[1]Frayne DJ, Verbiest S, Chelmow D, et al. Health care system measures to advance preconception wellness: Consensus recommendations of the clinical workgroup of the national preconception health and health care initiative. Obstet Gynecol. 2016;127(5):863-872

Table 5.2. Weighted Percentages (and Confidence Intervals) of Georgia PRAMS Respondent Characteristics by Preterm Birth Status, 2009-2013

Characteristic	Total *N* = 5157	Not Preterm *n* = 4002	Preterm Birth *n* = 1155	p-value [a]
Race/Ethnicity				
White, non-Hispanic	46.0 (43.9-48.2)	47.1 (44.8-49.4)	36.0 (30.7-41.6)	
Black, non-Hispanic	31.7 (29.7-33.7)	30.6 (28.5-32.8)	41.8 (36.5-47.2)	
Hispanic	16.6 (15.0-18.3)	16.8 (15.0-18.6)	15.4 (11.5-20.5)	0.0010
Other, non-Hispanic	5.7 (4.7-6.7)	5.6 (4.6-6.7)	6.9 (4.3-10.7)	
Maternal Age				
< 20 years	10.6 (9.5-11.7)	10.8 (9.7-12.0)	8.6 (7.0-10.6)	
20-29 years	54.6 (52.4-56.7)	54.1 (51.8-56.3)	59.1 (53.9-64.3)	0.1042
≥ 30 years	34.9 (32.8-36.9)	35.1 (33.0-37.3)	32.3 (27.3-37.2)	
Maternal Education				
<High school	18.8 (17.1-20.5)	18.5 (16.6-20.3)	22.0 (17.1-26.9)	
High school Graduate	31.4 (29.4-33.5)	31.2 (29.0-33.4)	33.4 (28.1-38.7)	0.1517
Some college	23.5 (21.6-25.4)	23.5 (21.5-25.5)	23.5 (18.7-28.4)	
College Graduate	26.3 (24.4-28.1)	26.8 (24.8-28.9)	21.1 (16.7-25.5)	
Marital Status				
Married	53.2 (51.0-55.3)	54.6 (52.3-56.9)	40.0 (34.7-45.4)	
Other	46.8 (44.7-49.0)	45.4 (43.1-47.7)	60.0 (54.6-65.3)	<.0001
Urban/Rural Status				
Urban County	73.8 (71.9-75.7)	74.3 (72.3-76.3)	68.8 (63.4-74.2)	
Rural County	26.2 (24.3-28.1)	25.7 (23.7-27.7)	31.2 (25.8-36.6)	0.0504
Payment for Delivery				
Private Insurance	36.8 (34.6-38.9)	37.3 (35.0-39.6)	31.5 (26.2-36.7)	
Medicaid	48.0 (45.8-50.2)	47.2 (44.8-49.6)	55.7 (49.9-61.5)	0.0306
Other	15.2 (13.6-16.9)	15.5 (13.7-17.2)	12.8 (8.6-17.1)	
Medical Risk Factor				
Yes	12.1 (10.7-13.5)	10.8 (9.3-12.2)	24.7 (20.0-29.4)	
No	87.9 (86.5-89.3)	89.2 (87.8-90.7)	75.3 (70.6-80.0)	<.0001
PCW Indicators				
Pregnancy Intention	49.2 (47.0-51.3)	49.6 (47.3-51.9)	45.5 (39.9-51.0)	
Access to Care	82.8 (81.1-84.4)	83.4 (81.7-85.2)	76.8 (71.6-81.9)	
Folic Acid Use	37.8 (35.7-39.8)	38.3 (36.0-40.5)	33.0 (27.9-38.2)	
Tobacco Avoidance	81.8 (80.1-83.5)	81.8 (80.0-83.6)	81.8 (77.5-86.0)	
Depression screening/treatment	7.7 (6.6-8.8)	7.3 (6.1-8.4)	12.1 (8.3-15.9)	
Healthy Weight	43.0 (40.9-45.1)	43.2 (40.9-45.5)	40.9 (35.5-46.4)	
Absence of STI	96.9 (96.2-97.7)	96.9 (96.1-97.7)	97.1 (95.3-98.9)	
Diabetes screening/treatment	10.9 (9.6-12.3)	10.4 (9.0-11.8)	16.0 (11.6-20.3)	
Teratogen Avoidance	87.9 (86.5-89.2)	88.2 (86.7-89.7)	84.6 (80.9-88.2)	
Cumulative PCW Indicators				
1-3	14.0 (12.4-15.5)	13.7 (12.1-15.3)	16.1 (11.9-20.3)	
4-6	74.5 (72.7-76.4)	74.5 (72.5-76.5)	74.8 (70.0-79.6)	0.2511
7-9	11.5 (10.1-12.9)	11.8 (10.3-13.2)	9.1 (6.0-12.2)	

Note: PRAMS: Pregnancy Risk Assessment Monitoring System; PCW: Preconception Wellness; STI: Sexually Transmitted Infection

[a] Rao-Scott Chi-square Test for Weighted Data

Table 5.3. Specific Preconception Wellness (PCW) Indicator Models for Predicting Preterm Birth

PCW Indicator	Unadjusted OR	Adjusted OR [a]	Adjusted OR [b]
Pregnancy Intention	0.85 (0.67-1.08)	1.21 (0.90-1.63)	1.29 (0.93-1.79)
Access to Care	**0.69 (0.48-0.90)**	0.76 (0.53-1.09)	0.73 (0.50-1.07)
Folic Acid Use	0.80 (0.62-1.02)	1.02 (0.77-1.37)	0.93 (0.68-1.27)
Tobacco Avoidance	1.00 (0.73-1.36)	1.00 (0.69-1.43)	1.10 (0.75-1.62)
Depression screening/treatment	**1.75 (1.18-2.61)**	**1.87 (1.20-2.91)**	1.53 (0.92-2.52)
Healthy Weight	0.91 (0.71-1.16)	0.98 (0.75-1.28)	0.98 (0.74-1.29)
Absence of STI	1.07 (0.57-2.02)	1.34 (0.62-2.89)	1.37 (0.61-3.05)
Diabetes screening/treatment	**1.64 (1.15-2.35)**	**1.59 (1.07-2.38)**	1.28 (0.83-1.99)
Teratogen Avoidance	0.73 (0.54-1.00)	**0.69 (0.47-0.99)**	0.80 (0.53-1.20)

OR: odds ratio; STI: Sexually Transmitted Infection

Note: The reference group for each specific PCW indicator models was individuals who did not experience the desired PCW indicator.

[a] Adjusted for race/ethnicity, payment for delivery, marital status, and medical risk factor(s).

[b] Adjusted for race/ethnicity, payment for delivery and marital status, medical risk factor(s), and all other PCW indicators.

Table 5.4. Adjusted odds ratios (OR) and confidence intervals (CI) for predicting preterm birth (PTB) among Georgia PRAMS respondents, 2009-2013

Characteristic	OR[a]	95% CI
Cumulative PCW Indicators		
1-3	1	Reference
4-6	0.67	0.35-1.27
7-9	0.41	0.14-1.22
Maternal Race/Ethnicity		
NH White	1	Reference
NH Black	1.53	1.08-2.17
Hispanic	1.11	0.69-1.79
NH Other	1.89	1.05-3.04
Marital Status		
Married	1	Reference
Other	1.55	1.06-2.27
Payment for Delivery		
Private Insurance	1	Reference
Medicaid	1.08	0.75-1.56
Other	0.88	0.55-1.41
Medical Risk Factor		
No	1	Reference
Yes	2.87	2.07-3.97

Note: PRAMS: Pregnancy Risk Assessment Monitoring System; PCW: Preconception Wellness
[a] Adjusted for race/ethnicity, payment for delivery, marital status, medical risk factor(s) and all PCW indicators experienced.

CHAPTER 6

PREDICTORS OF PRETERM BIRTH CLINICAL SUBTYPES AND ITS ASSOCIATION WITH PRECONCEPTION WELLNESS[3]

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[3] Kanu FA, Salm Ward TC, Shen Y, Miles T, and Cordero JF. To be submitted to *Journal of Women's Health*.

Abstract

Background: There is a substantial and distinct etiologic heterogeneity in the clinical subtypes of preterm birth (PTB), namely, spontaneous and medically induced PTB. The purpose of this paper was to examine the association between preconception wellness (PCW) and PTB clinical subtypes as previously defined.

Methods: Data were collected during 2009-2013 in the Georgia Pregnancy Risk Assessment Monitoring System (PRAMS), a state specific population-based surveillance system that collects data on select maternal behaviors and experiences occurring before, during, and shortly after pregnancy. Preconception wellness indicators experienced per mom were summed and categorized as 1-3, 4-6, and 7-9 for analysis. PTB due to preterm rupture of membranes and not induction was classified as spontaneous preterm birth (SPTB). Induction of labor or delivery via caesarean section was classified as medically induced preterm birth (MIPTB). Descriptive statistics, bivariate analyses, and logistic regression models assessed the experience of preconception wellness individually and cumulatively by SPTB and MIPTB.

Results: Overall, 91.1% of Georgia women had a full term infant, 7.7% had a SPTB, and 1.2% had a MIPTB. Results of the logistic regression models examining the effects of each PCW indicator determined that after adjusting for significant maternal characteristics, depression and diabetes screening/treatment remained significantly associated with increased odds of SPTB but were not significantly associated after adjusting for maternal characteristics and all other reported PCW indicators. In all MIPTB models, after adjusting for significant maternal characteristics and all other PCW indicators, absence of sexually transmitted infections (STIs) was significantly associated

with increased odds of MIPTB. As the number of cumulative PCW indicators increased, the odds of SPTB decreased and the odds of MIPTB increased; however, these trends were not significantly different from moms who experienced 1 to 3 PCW indicators
Conclusion: Based on our findings, the association between an increased experience of PCW indicators and SPTB or MIPTB was not significant. Though the results did not support our hypothesis, with additional data collected, differential risk factors could be detected, which could inform resource limited agencies in focusing on a few highly significant factors.

Key words: preconception wellness, PRAMS, spontaneous preterm birth, medically induced preterm birth pregnancy

Introduction

Though preterm birth (PTB) rates have declined in the past, rates have not changed in recent years. In fact, there has been a slight yet meaningful increase in the national rate of PTB (9.6%) in 2015, the first increase in the rate since its decline in 2007[1,2]. The nation's strategy for improving pregnancy outcomes such as PTB include the use of and access to early and adequate prenatal care[3]. However, the notion that the short period of prenatal care can reverse the impact of early life programming and cumulative allostatic load on a woman's reproductive health may be impractical due to unknown exposure to potential teratogens that may occur during the first few weeks of pregnancy, before prenatal care is sought[4]. The growing consensus is that preconception care as an integral part of a woman's health care continuum, rather than prenatal care, can identify social, behavioral, environmental, and biomedical risks to a woman's fertility and pregnancy outcome and reduce these risks through education, counseling, and appropriate intervention before conception[5,6].

The obstetric precursors leading to PTB include 1) spontaneous labor with intact membranes, 2) preterm premature rupture of the membranes (PPROM), and 3) labor induction or caesarean delivery for maternal or fetal indications[7-9]. There is a substantial and distinct etiologic heterogeneity in the clinical subtypes of PTB, namely, spontaneous and medically induced PTB. The etiology of these underlying clinical subtypes varies across and within population by patient characteristics, physician practice patterns, and maternal race/ethnic composition[10]. Because of this, the classification of PTB clinical subtypes continues to be called into question[11,12].

The purpose of this paper is to examine the association between preconception wellness (PCW) and PTB clinical subtypes as previously defined. Given the distinct etiologic heterogeneity of the PTB clinical subtypes, we hypothesize that the more cumulative PCW indicators a woman experiences decreases her odds of either spontaneous or medically induced PTB. To date, no study has utilized this distinct methodology to examine the association between PCW and PTB clinical subtypes. Additionally, we anticipate differences in risk profiles that can inform prevention strategies.

Methods

Data Source

Pregnancy Risk Assessment Monitoring System (PRAMS) is a multi-state, population-based surveillance project conducted by states in collaboration with the Centers for Disease Control and Prevention (CDC) designed to monitor the health of mothers and babies. Georgia PRAMS 2009-2013 data were obtained from the Georgia Department of Public Health. PRAMS data supplements birth certificate data on select maternal behaviors and experiences that occurred before, during, and after pregnancy[13]. To be eligible to participate in Georgia PRAMS, participants must be a Georgia resident who delivered a live infant. Data are collected by the Georgia Department of Public Health via mail questionnaires and follow-up phone interviews for mail non-response[14].

Study Population

Each month, the Georgia Department of Public Health draws a systematically random sample of approximately 100-200 women from Georgia's birth certificate registry. Women were sampled two to six months post-delivery. PRAMS sites oftentimes oversample subpopulations to draw stronger conclusions about various factors of interest. From 2009-2013, 8,325 women were invited to participate in Georgia PRAMS and 5,453 completed the survey. The survey response rate for each year met the CDC threshold of 65%, ranging from 65.2% to 66.1% with an overall unweighted response rate of 65.5%. PRAMS data were weighted by CDC to ensure that the sample drawn by the Georgia Department of Public Health was representative of all women who had a live birth in Georgia. This research was reviewed and approved by the Georgia Department of Public Health and the University of Georgia Institutional Review Boards.

Preconception Wellness Indicators

Preconception wellness (PCW) indicators were identified in the literature[15] and are summarized in Table 1. In this analysis, PCW indicators were based on nine questions about events that may have occurred at least 1 month before the new baby was born. PCW indicators were analyzed using 2 distinct methods. First, the impact of each individual PCW indicator was examined. Second, a cumulative PCW score was calculated by adding the number of PCW indicators each participant reported experiencing to create a composite score ranging from 0 (no PCW indicators experienced) to 9 (all PCW indicators experienced). All PCW indicators were reclassified as a dichotomous variable that compared the desired behavior to the undesired behavior.

Preterm Birth

Gestational age at birth was ascertained from the birth certificate and used to determine the pregnancy outcome of interest in this study. Preterm birth (PTB) was defined as any live birth between 20 and 36 completed weeks' gestation or fewer than 259 days determined by obstetric estimate of gestation at delivery. The classification of the PTB subtypes were adapted from previous literature[8]. PTB due to preterm rupture of membranes and not induction was classified as spontaneous preterm birth (SPTB). Induction of labor or delivery via caesarean section was classified as medically induced preterm birth (MIPTB).

Maternal Characteristics

Maternal race/ethnicity was classified as either Hispanic or non-Hispanic (NH), and non-Hispanic was categorized as NH White, NH Black, or NH Other. Maternal age was categorized as less than 20 years of age, 20-29 years of age, and 30 years of age or older. Maternal education was categorized as less than high school, high school graduate, some college, and four or more years of college. Marital status was categorized as married or other. Urban/Rural status was determined by the urban/rural status of the county where participants resided. Payment for delivery was used as a proxy for socioeconomic status and was categorized as private insurance, Medicaid, or other. Medical risk factor was designated as yes/no – medical risk factor was coded 'yes' if a participant had pre-pregnancy or gestational hypertension, pre-pregnancy or gestational diabetes, a previous preterm birth, vaginal bleeding, or previous adverse pregnancy outcomes. Primiparous was categorized as 'yes' if participants had never given birth to a live infant or 'no' if participants gave birth to a live infant previously. Health insurance before pregnancy was coded as 'yes' if participants reported having any type of health insurance during the month before they got pregnant.

Insurance status before pregnancy and all PCW indicators except absence of sexually transmitted infection (STI) were ascertained from the Georgia PRAMS questionnaire. The remaining variables were ascertained from Georgia birth certificate data, including maternal race/ethnicity, age, education, marital status, payment for delivery, urban/rural status, primiparity, medical risk factor, and STI presence/treatment during pregnancy.

Statistical Analysis

Rao-Scott chi-square tests for weighted data were performed to detect statistical differences ($p<0.05$) between PTB clinical subtypes and PCW indicators. To assess maternal characteristics and its association with PTB subtypes, logistic regression models accounting for varying covariate adjustment levels were run. Variables were selected for inclusion in the final model using manual forward selection. Variables were retained if their addition to the full model resulted in a significant difference ($p<0.05$) in the -2 log likelihood of the full and reduced models or based on *a priori* knowledge.

Odds ratios (OR) and their corresponding 95% confidence intervals (CI) were presented. Associations were considered statistically significant if CIs for the corresponding OR did not include 1. SAS 9.4 (SAS Institute, Cary, NC) and SAS-Callable SUDAAN 11.0.1 (Research Triangle Institute, Research Triangle Park, NC) were used to conduct all statistical analyses while accounting for complex survey weights. Figure 6.1 illustrates the inclusion and exclusion flow chart for analysis. Participants were excluded from analysis if they 1) did not respond to the Georgia PRAMS questionnaire (N = 2,872), 2) delivered a non-singleton infant (e.g., twins, triplets, etc.) or if plurality was missing (N = 261), 3) PTB clinical subtypes were unable to be determined (N = 32), and 4) if gestational age was less than 20 weeks (N=27).

Results

<u>Participant Characteristics</u>

A total of 5,453 women responded to the Georgia PRAMS survey from 2009-2013. After excluding 320 participants who had non-singleton births, unknown PTB clinical subtype, or an infant less than 20 weeks' gestation, 5,133 remained for analysis. Characteristics of the study population by term were described in Table 2. Overall, 91.1% of Georgia women had a full term infant, 7.7% had a spontaneous preterm birth (SPTB), and 1.2% had a medically induced preterm birth (MIPTB). Differences in PTB clinical subtypes were significant by race/ethnicity, marital status, medical risk factor, and primiparity. Women who were Non-Hispanic (NH) Black (versus NH White), not married, and had a medical risk factor had significantly higher rates of SPTB. Women who were Non-Hispanic (NH) Black (versus Hispanic) and had a medical risk factor had significantly higher rates of MIPTB (Table 2).

<u>Specific PCW Indicators</u>

Results of the logistic regression models examining the effects of each PCW indicator determined that in the unadjusted models, depression and diabetes screening/treatment were significantly associated with increased odds of SPTB. After adjusting for significant maternal characteristics, depression and diabetes screening/treatment remained significantly associated with increased odds of SPTB but was not significantly associated after adjusting for maternal characteristics and all other reported PCW indicators. In the unadjusted MIPTB models, prenatal care visit within the 1st trimester (access to care) and teratogen avoidance were significantly associated with decreased odds of MIPTB (Table 3). After adjusting for significant maternal characteristics and all other PCW indicators, absence of sexually transmitted infections (STIs) was significantly associated with increased odds of MIPTB. Estimates among PCW indicators were calculated to assess multicollinearity for each PCW indicator logistic regression model. PCW indicators were not highly correlated given that the variance-inflation factor ranged from 1.01-1.14 and tolerance ranged from 0.88-0.99.

Cumulative Preconception Wellness Indicators

Results for the weighted cumulative PCW indicator logistic regression models predicting SPTB and MIPTB were presented in Table 4. Significantly higher odds of SPTB were identified among mothers who were non-Hispanic (NH) Other (compared to NH White, OR=1.97 [95% CI: 1.07-3.62]), non-primiparous (compared to primiparous, OR = 1.39 [95% CI: 1.03-1.89]), and had a medical risk factor (compared to no medical risk factor, OR = 2.67 [95% CI: 1.88-3.81]). As the number of cumulative PCW indicators increased, the odds of SPTB decreased; however, this decrease was not significantly different from moms who experienced 1 to 3 PCW indicators (Table 4).

Significantly higher odds of MIPTB were identified among mothers who were NH Black (compared to NH White, OR=2.21 [95% CI: 1.02-4.78]) and had a medical risk factor (compared to no medical risk factor, OR = 5.67 [95% CI: 2.81-11.42]). Mothers who were not primiparious had a significantly decreased odds of MIPTB (compared to primiparious moms, OR = 0.45 [95% CI: 0.22-0.91]). As the number of cumulative PCW indicators increased, the odds of MIPTB increased; however, this increase was not significantly different from moms who experienced 1 to 3 PCW indicators (Table 4).

Discussion

The purpose of this study was to examine the association between preconception wellness (PCW) and preterm (PTB) clinical subtypes. We hypothesized that cumulative PCW indicators predict spontaneous and medically induced PTB. Based on our findings, the association between an increased experience of PCW indicators and SPTB or MIPTB was not significant (Table 4). These findings were consistent with our previous research concluding that as the experience of PCW indicators increased, the odds of PTB was not significantly decreased[16].

When the effect of specific PCW indicators on SPTB were examined, we found that depression and diabetes screening/treatment was significantly associated with decreased odds of SPTB. The significant finding remained after adjusting for all significant maternal characteristics but not all other PCW indicators. Similar findings were observed when examining the association between PCW indicators and overall preterm birth[16]. A meta-analysis conducted by Grote and colleagues[17] supported the public health significance of the modest yet statistically significant association between antenatal depression and odds of PTB. Given the overwhelming evidence illustrating the increased odds of preterm birth, and in this study specifically SPTB, we suggest a call to action surrounding mental health, specifically prior to conception. Screening and treating women for depression, could lower their odds for having a preterm infant. With the current questionnaire, Georgia PRAMS continues to inquire about mental health concerns such as prepregnancy depression, if participants had a visit with a healthcare provide regarding depression or anxiety, and if participants spoke with a healthcare provide about feeling down or depressed[18]. We suggest that the Georgia Department of Public Health's maternal and child health programs include messaging regarding the importance of mental health, and that providers screen for depression at every visit, referring those who are positive for further treatment.

When we examined the effect of individual PCW indicators on the odds of MIPTB, we found that prenatal care within the 1st trimester (access to care) and teratogen avoidance significantly decreased the odds of MIPTB. These findings correspond with previous research from the West Los Angeles Preterm Birth Prevention Project concluding dedicated preterm birth prevention clinics that provide additional education and offer more clinic attendances resulted in a 19% reduction (9.1-7.4%) in preterm birth rate compared to control clinics[19]. Additionally, Newnham and colleagues[19] suggest that the most feasible approach to rapidly lowering the overall preterm birth rate is to address non-medically indicated late preterm birth.

In our cumulative PCW indicator logistic regression model, we found that as the number of PCW indicators increased, the odds of SPTB and MIPTB did not decrease as originally hypothesized. These results were consistent with our previous research that found as the number of PCW indicators increased, the odds of PTB was not significantly lowered[16]. One potential reason for this inconsistent finding could be how PTB clinical subtypes were classified. Given that reclassification was done a posteriori rather than by the physician at the time of birth there was the potential for misclassification that may have led to the current findings.

Specifically in our study, factors such as primiparity, marital status, and presence of a medical risk factor increased a women's odds of a spontaneous preterm birth. Marital status was the only factor that significantly increased a women's odds of a medically induced preterm birth. However, parous women had decreased odds of MIPTB and increased odds of SPTB. Ananth and colleagues[20] suggested three distinct risk groups for PTB, including 1) a 'low risk' group comprised of women with prior term birth, 2) an 'intermediate risk' group of women who are primiparous, and 3) a 'high risk' group comprised of women with a prior preterm birth.

There were limitations to this study that may hinder the ability to apply these findings to all Georgia women. First, Georgia PRAMS was not representative of all pregnancies; women who had an abortion or experienced a fetal death (miscarriage or stillbirth) were not represented in this analysis. Women who experience an abortion or fetal death may experience different risk factors than women whose pregnancy resulted in a live birth[21-23]. Second, there was the potential for non-coverage and non-response bias due to data collection via mail and telephone. However, Georgia PRAMS data were weighted by the CDC to adjust for sampling probabilities, non-response, and non-coverage; therefore, the potential for non-coverage and non-response bias were minimized[24]. Third, respondents were asked to complete the questionnaire between 2 and 9 months postpartum, when preconception recall may have declined. Fourth, recall bias related to experience of PCW indicators or reclassifying the PCW indicators may have introduced differential misclassification. That is, women with a PCW experience could have been misclassified as not experiencing the PCW indicator or vice versa. Differential misclassification is non-random and can result in an erroneous effect estimate. Furthermore, there was the potential for differential misclassification of PTB clinical subtypes. Classification of SPTB and MIPTB were based on Georgia birth certificate data. Although, the etiology of these underlying clinical subtypes varies considerably across and within populations, the stratification of preterm birth based on clinical subtypes remain controversial and some propose a 5-component classification system including significant maternal conditions, significant fetal conditions, placental pathologic conditions, signs of initiation of parturition, and pathway to delivery (caregiver initiation vs. spontaneous)[10,12,25].

Since differential misclassification cannot be corrected using statistical methods, we suggest a revision to the next phase of the Georgia PRAMS questionnaire to accurately measure each PCW indicator. These nine indicators were recently developed and there is an opportunity for PRAMS to assess them more thoroughly. A revision is also warranted since neither the birth certificate nor Georgia PRAMS inquired about the presence of a sexually transmitted infection (STI) *before* pregnancy but rather presence/treatment of STI *during* pregnancy. We also suggest that birth certificate data include physician notes on the 5 suggested components to capture robust data on adverse birth outcomes. These revisions will allow for accurate monitoring of preconception wellness and preterm birth in Georgia.

In spite of these limitations, PRAMS remains a unique source essential for monitoring maternal and child health indicators at the state level. PRAMS allows sites to oversample on various factors of interest in order to draw stronger conclusions. We suggest that Georgia PRAMS considers oversampling based on infant term (preterm or full term) to allow for this subpopulation to be studied more thoroughly. PRAMS utilizes a standardized data collection methodology, allowing for comparison across other participating PRAMS sites. Furthermore, PRAMS is an anonymous survey. Its anonymity decreases the potential for reporting bias due to fear of stigmatization. Lastly, the overall response rate to Georgia PRAMS was relatively high from 2009-2013 (approximately 66%), minimizing the probability of non-response and non-coverage bias.

Conclusion

This study recognizes preterm birth as multifaceted with at least two distinct clinical pathways: spontaneous and medically induced preterm birth. The odds of each PTB clinical subtype decreased differently depending on the PCW indicator experienced. Though the results did not support our hypothesis, with additional data collected, differential risk factors could be detected, which could inform resource limited agencies in focusing on a few highly significant factors.

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Figure 6.1. Study Sample Inclusion/Exclusion Flowchart, Georgia Pregnancy Risk Assessment Monitoring System 2009-2013

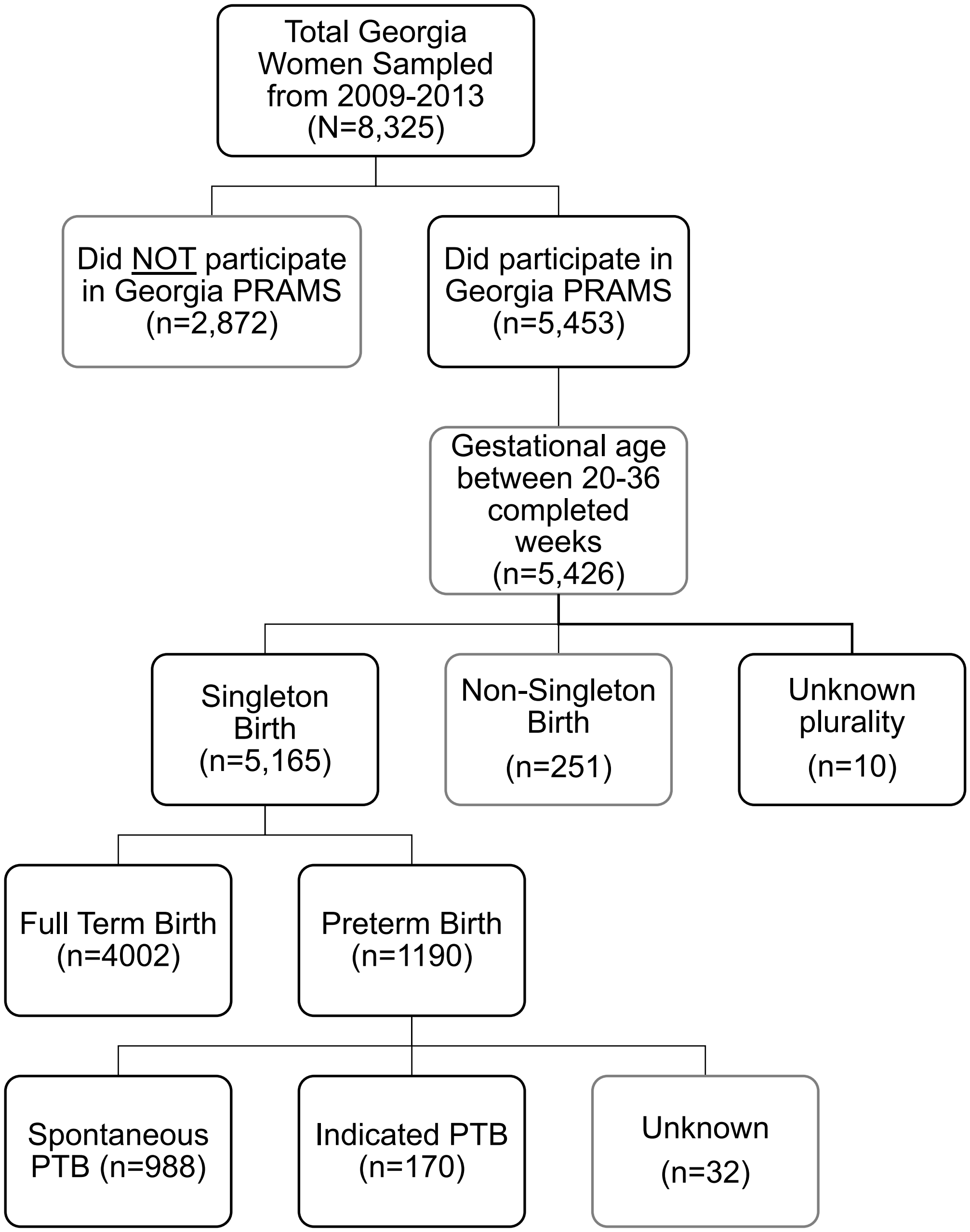

Table 6.1. Georgia Pregnancy Risk Assessment Monitoring System (PRAMS) Preconception Wellness (PCW) Indicators[1] Reclassified

PCW Indicator	PRAMS Survey Question	Available Answer Choice	Reclassified Response
Pregnancy intention	Thinking back to just before you got pregnant with your new baby, how did you feed about becoming pregnant?	☐ I wanted to be pregnant later ☐ I wanted to be pregnant sooner ☐ I wanted to be pregnant then ☐ I didn't want to be pregnant then or at any time in the future ☐ I wasn't sure what I wanted	☐ Yes: I wanted to be pregnant then ☐ No: All other answer choices
Access to care	How many weeks or months pregnant were you when you had your first visit for prenatal care?	___Weeks or ___Months	☐ Yes: Within 1st Trimester ☐ No: Not within 1st Trimester
Folic acid use	During the month before you got pregnant with your new baby, how many times a week did you take a multivitamin, a prenatal vitamin, or folic acid vitamin?	☐ I didn't take a multivitamin, prenatal vitamin, or folic acid vitamin the *month before* I got pregnant ☐ 1 to 3 times a week ☐ 4 to 6 times a week ☐ Every day of the week	☐ Yes: took a multivitamin at least once per week ☐ No: Didn't take a multivitamin
Tobacco avoidance	Have you smoked any cigarettes in the past 2 years?	☐ Yes ☐ No	---
Depression screening/treatment	During the 12 months before you got pregnant with your new baby, did you visit a health care worker to be checked or treated for depression or anxiety?	☐ Yes ☐ No	---
Healthy weight	How tall are you without shoes? & Just before you got pregnant with your new baby, how much did you weigh?	___Feet ___Inches ___Pounds ___Kilos	Calculated body mass index (BMI) ☐ Yes: Normal BMI (18.5-24) ☐ No: All other BMI levels
Sexually transmitted infection (STI) presence/treatment	*STI present/treated during pregnancy was ascertained from the birth certificate*	☐ Chlamydia ☐ Gonorrhea ☐ Hepatitis B ☐ Hepatitis C ☐ Syphilis	☐ Yes: at least 1 STI present/treated during pregnancy ☐ No: No STIs present/treated during pregnancy
Diabetes screening/treatment	During the 12 months before you got pregnant with your new baby, did you visit a health care worker to be checked or treated for diabetes?	☐ Yes ☐ No	---
Teratogen avoidance in chronic conditions	During the 12 months before you got pregnant with your new baby, were you regularly taking prescription medicines other than birth control?	☐ Yes ☐ No	---

[1]Frayne DJ, Verbiest S, Chelmow D, et al. Health care system measures to advance preconception wellness: Consensus recommendations of the clinical workgroup of the national preconception health and health care initiative. Obstet Gynecol. 2016;127(5):863-872

Table 6.2. Weighted Percentages (and Confidence Intervals) of Georgia PRAMS Respondent Characteristics by Preterm Birth (PTB) Subtype, 2009-2013

	Spontaneous PTB *n* **= 961**	**Medically Induced PTB** *n* **= 167**	**Full Term** *n* **= 4002**	***p-value*** [a]
TOTAL	7.7 (6.8-8.6)	1.2 (0.9-1.5)	91.1 (90.1-92.0)	
Race/Ethnicity				
White, non-Hispanic	6.0 (4.8-7.3)	1.0 (0.5-1.4)	93.0 (91.6-94.3)	
Black, non-Hispanic	9.9 (8.3-11.6)	1.9 (1.1-2.7)	88.2 (86.3-90.0)	
Hispanic	7.1 (4.6-9.5)	0.4 (0.2-0.7)	92.5 (90.0-94.9)	0.0008
Other, non-Hispanic	10.4 (5.4-15.3)	1.2 (0.0-3.0)	88.5 (83.2-93.7)	
Maternal Age				
< 20 years	6.1 (4.6-7.6)	1.2 (0.7-1.8)	92.7 (91.0-94.3)	
20-29 years	8.4 (7.0-9.8)	1.1 (0.6-1.6)	90.5 (89.0-92.0)	0.2691
≥ 30 years	7.1 (5.8-8.5)	1.4 (0.8-1.9)	91.5 (90.0-93.0)	
Maternal Education				
< High school	9.1 (6.6-11.6)	0.9 (0.6-1.2)	90.0 (87.5-92.6)	
High school Graduate	8.0 (6.4-9.6)	1.4 (0.6-2.2)	90.6 (88.8-92.4)	0.4052
Some college	8.2 (6.1-10.3)	1.1 (0.5-1.7)	90.7 (88.5-92.9)	
College Graduate	6.2 (4.6-7.7)	1.3 (0.6-2.0)	92.5 (90.8-94.2)	
Marital Status				
Married	6.0 (4.9-7.0)	0.9 (0.5-1.2)	93.1 (92.0-94.2)	<.0001
Other	9.7 (8.1-11.2)	1.6 (1.0-2.2)	88.7 (87.1-90.4)	
Urban/Rural Status				
Urban County	7.6 (6.5-8.6)	1.2 (0.8-1.6)	91.2 (90.1-92.3)	0.8597
Rural County	8.2 (6.3-10.1)	1.2 (0.5-2.0)	90.6 (88.6-92.6)	
Payment for Delivery				
Private Insurance	6.9 (5.5-8.3)	1.2 (0.6-1.9)	91.9 (90.3-93.4)	
Medicaid	9.3 (7.8-10.8)	1.2 (0.7-1.7)	89.5 (87.9-91.1)	0.1364
Other	6.7 (4.1-9.3)	0.7 (0.0-1.3)	92.6 (89.9-95.3)	
Medical Risk Factor				
Yes	15.5 (11.9-19.1)	3.4 (1.8-5.0)	81.1 (77.2-85.0)	<.0001
No	6.8 (5.8-7.7)	0.7 (0.4-1.0)	92.5 (91.5-93.5)	
Primiparous				
Yes	6.5 (5.3-7.7)	1.7 (1.0-2.3)	91.8 (90.5-93.2)	0.0031
No	8.7 (7.3-10.0)	0.8 (0.5-1.1)	90.5 (89.2-91.9)	
Health Insurance Before Pregnancy				
Yes	7.7 (6.6-8.8)	1.3 (0.8-1.8)	91.0 (89.8-92.2)	0.7235
No	7.8 (6.2-9.4)	1.0 (0.5-1.5)	91.2 (89.5-92.8)	
Cumulative PCW				
Indicators	7.4 (5.1-9.7)	2.1 (0.8-3.5)	90.4 (87.8-93.1)	
1-3	8.1 (7.0-9.2)	0.9 (0.6-1.2)	91.0 (89.9-92.1)	0.1171
4-6	5.9 (3.7-8.1)	1.7 (0.2-3.2)	92.4 (89.8-95.1)	
7-9				

Note: PRAMS: Pregnancy Risk Assessment Monitoring Systems
[a] Rao-Scott Chi-square Test for Weighted Data

Table 6.3. Specific Preconception Wellness (PCW) Indicator Models for Predicting Spontaneous Preterm Birth (SPTB) and Medically Inducted Preterm Birth (MIPTB)

	PCW Indicator	Unadjusted OR	Adjusted OR[a]	Adjusted OR[b]
SPTB	Pregnancy Intention	0.85 (0.66-1.11)	1.12 (0.81-1.54)	1.17 (0.82-1.67)
	Access to Care	0.84 (0.59-1.20)	0.93 (0.63-1.37)	0.91 (0.60-1.38)
	Folic Acid Use	0.76 (0.58-1.00)	0.95 (0.69-1.30)	0.87 (0.62-1.22)
	Tobacco Avoidance	0.96 (0.69-1.34)	0.94 (0.65-1.36)	1.02 (0.69-1.51)
	Depression Screening/Treatment	**1.67 (1.09-2.56)**	**1.80 (1.15-2.84)**	1.48 (0.88-2.50)
	Healthy Weight	0.86 (0.66-1.11)	0.93 (0.70-1.23)	0.93 (0.69-1.24)
	Absence of STI	0.95 (0.46-1.96)	1.12 (0.51-2.44)	1.13 (0.51-2.54)
	Diabetes Screening/Treatment	**1.54 (1.05-2.26)**	**1.55 (1.02-2.36)**	1.31 (0.83-2.09)
	Teratogen Avoidance	0.77 (0.54-1.08)	0.69 (0.47-1.03)	0.81 (0.53-1.24)
MIPTB	Pregnancy Intention	0.90 (0.50-1.61)	1.36 (0.73-2.50)	1.35 (0.76-2.41)
	Access to Care	**0.46 (0.23-0.91)**	0.52 (0.23-1.17)	0.43 (0.19-1.01)
	Folic Acid Use	1.09 (0.60-1.99)	1.83 (0.90-3.71)	1.65 (0.80-3.39)
	Tobacco Avoidance	1.44 (0.70-2.97)	1.69 (0.62-4.59)	1.96 (0.70-5.48)
	Depression Screening/Treatment	1.64 (0.63-4.24)	1.63 (0.50-5.33)	1.10 (0.27-4.50)
	Healthy Weight	0.86 (0.48-1.53)	1.19 (0.60-2.35)	1.14 (0.57-2.30)
	Absence of STI	2.46 (0.61-9.81)	5.87 (0.90-38.28)	**7.35 (1.02-52.93)**
	Diabetes Screening/Treatment	1.65 (0.67-4.02)	1.44 (0.55-3.78)	0.94 (0.26-3.43)
	Teratogen Avoidance	**0.46 (0.23-0.93)**	0.48 (0.19-1.20)	0.46 (0.17-1.20)

Note: The reference group for the specific PCWs comprises of individuals who did not experience the particular PCW.
[a] Adjusted for race/ethnicity, payment for delivery, marital status, medical risk factor(s), and primiparity.
[b] Adjusted for race/ethnicity, payment for delivery, marital status, medical risk factor(s), primiparity, and all other PCW indicators.

Table 6.4. Adjusted Odds Ratios (OR) and Confidence Intervals (CI) for predicting spontaneous (SPTB) and medically induced preterm birth (MIPTB), Georgia PRAMS respondents, 2009-2013

	SPTB		MIPTB	
Characteristic	**OR[a]**	**95% CI**	**OR[a]**	**95% CI**
Cumulative PCW Indicators				
1-3	1	Reference	1	Reference
4-6	0.75	0.37-1.51	0.48	0.08-2.78
7-9	0.46	0.14-1.47	0.84	0.07-10.51
Maternal Race/Ethnicity				
NH White	1	Reference	1	Reference
NH Black	1.47	1.03-2.11	2.21	1.02-4.78
Hispanic	1.20	0.73-1.96	0.66	0.22-1.97
NH Other	1.97	1.07-3.62	1.81	0.30-10.87
Primiparious				
Yes	1	Reference	1	Reference
No	1.39	1.03-1.89	0.45	0.22-0.91
Marital Status				
Married	1	Reference	1	Reference
Other	1.42	0.94-2.14	2.08	0.88-4.92
Payment for Delivery				
Private Insurance	1	Reference	1	Reference
Medicaid	1.06	0.72-1.55	0.99	0.34-2.86
Other	0.86	0.52-1.41	0.75	0.17-3.23
Medical Risk Factor				
No	1	Reference	1	Reference
Yes	2.67	1.88-3.81	5.67	2.81-11.42

Note: PRAMS: Pregnancy Risk Assessment Monitoring System

[a] Adjusted for race/ethnicity, payment for delivery, marital status, medical risk factor(s), primipartiy, and all other PCW indicators.

CHAPTER 7

DISCUSSION

Summary

This dissertation addressed the public health issue of preconception wellness, a woman's overall health before conception[1]. A woman's health in the preconception period is linked to both pregnancy and lifelong health outcomes for herself and her children[2]. Our study focused on Georgia mothers who participated in the Georgia Pregnancy Risk Assessment Monitoring System (PRAMS) from 2009 – 2013. The purpose of this research was to determine the extent to which the proposed quality metrics on preconception wellness predicted preterm birth in Georgia women using state surveillance data.

This goal was achieved by discussing three major areas of interest. First, aim 1 determined the feasibility of using Georgia PRAMS data to describe the prevalence of preconception wellness as defined by the Clinical Workgroup of the CDC Preconception Health and Health Care Initiative. Second, aim 2 examined the association between preconception wellness and preterm birth, hypothesizing that the more PCW indicators experienced, the lower the risk of preterm birth. Third, aim 3 examined the association between preconception wellness and preterm birth clinical subtypes as previously defined (spontaneous vs. medically induced preterm birth), hypothesizing that the more PCW indicators experienced, the lower the risk of either spontaneous or medically induced preterm birth.

All study aims were addressed using Georgia PRAMS data provided by the Georgia Department of Public Health. Georgia PRAMS is a state population-based survey that supplements birth certificate data on women's attitudes, experiences, and behaviors before, during, and shortly after pregnancy[3]. Although using Georgia PRAMS surveillance data to track and monitor preconception wellness was sufficient; however, there were suggested improvements to increase the strength of its feasibility. Using a state surveillance system allows for the Georgia Department of Public Health to determine a baseline and monitor changes in preconception wellness overtime. Though our results did not support our hypotheses in the initial analyses for aim 2 and 3, PRAMS utilizes a standardized methodology and we suggest that this study be replicated within other PRAMS sites to aid in the prioritization of preconception wellness in the United States.

Study Limitations and Strengths

There are limitations to this study that may hinder the ability to apply these findings to all Georgia women. Georgia PRAMS is not representative of all pregnancies; women who had an abortion or experienced a fetal death (miscarriage or stillbirth) were not represented in this analysis. Women who experience an abortion or fetal death may experience different risk factors than women whose pregnancy resulted in a live birth[4-6]. Since data were collected via mail and telephone, there is the potential for non-coverage and non-response bias. However, Georgia PRAMS data are weighted by CDC to adjust for sampling probabilities, non-response, and non-coverage; therefore, the potential for non-coverage and non-response bias were minimized[7].

Respondents were asked to complete the questionnaire between 2 and 9 months postpartum, when preconception recall may have declined. Additionally, recall bias related to experience of PCW indicators or reclassifying the PCW indicators may have introduced differential misclassification. That is, women without a PCW experience could have been misclassified as experiencing the PCW indicator or vice versa. Differential misclassification is non-random and can result in an erroneous effect estimate. Since differential misclassification cannot be corrected using statistical methods, we suggest a revision to the next phase of the Georgia PRAMS questionnaire to accurately measure each PCW indicator as recommended by the Clinical Workgroup of the CDC Preconception Health and Healthcare Initiative.

A revision is also warranted since neither the birth certificate nor Georgia PRAMS inquire about the presence of a sexually transmitted infection (STI) *before* pregnancy but rather presence/treatment of STI *during* pregnancy. Furthermore, a growing number of reproductive aged women are treated for chronic disease[8]. Recent studies found that in the first trimester, 80% of women take at least one prescription or over-the-counter medication[9]. The revision should also include questions inquiring about prescribed and over-the-counter medications taken before pregnancy to help determine which were teratogenic and compliance with taking these medications as noncompliance could have negative implications for preconception wellness. These revisions will allow for accurate monitoring of preconception wellness in Georgia.

In spite of these limitations, PRAMS remains a unique source and essential for monitoring maternal and child health indicators at the state level. PRAMS utilizes a standardized data collection methodology, allowing for comparison across other participating PRAMS sites. Furthermore, PRAMS is an anonymous survey. Its anonymity decreases the potential for reporting bias due to fear of stigmatization. Lastly, the overall response rate to Georgia PRAMS was relatively high from 2009-2013 (approximately 66%), minimizing the probability of non-response and non-coverage bias.

Suggestions for Future Research

The findings from this dissertation provide many directions for future research. The results in Aim 1 provide Georgia public health professionals with a baseline for preconception wellness among Georgia mothers. With this established baseline, the Maternal and Child Health Section of the Georgia Department of Public Health now have the methods needed to measure and track each preconception wellness indicator and monitor changes in preconception wellness over time. The analysis in Aim 2 supported the use of Clinical Workgroup's[1] conceptualization of preconception wellness (PCW) to examine the association between preconception wellness and preterm birth among Georgia mothers. Though Georgia's results did not show a significant association between preconception wellness and preterm birth, this methodology should be replicated within other PRAMS sites to aid in the prioritization of preconception wellness. The findings in Aim 3 recognized preterm birth as multifaceted with at least two distinct clinical pathways: spontaneous and medically induced preterm birth. We concluded that with additional data collected (i.e., birth certificate data including physician notes to assist in capturing robust data on adverse birth outcomes), differential risk factors could be detected to ultimately inform resource limited agencies in focusing on highly significant factors.

Conclusion

After applying our suggested revisions, Georgia PRAMS would be the ideal state surveillance system to describe preconception wellness. This study concludes that it is feasible to apply Clinical Workgroup's[1] conceptualization of preconception wellness (PCW) to state level surveillance data such as Georgia PRAMS. This study assessed preconception wellness via surveillance data to ultimately aid in the development of evidence-based guidelines that are incorporated into health practice and population health outcomes[10]. In applying this methodology, we also examined the association between preconception wellness, preterm birth overall, and by clinical subtype (spontaneous and medical induced). Our findings aid public health key stakeholders in making state and national comparisons that can be used for needs assessments, resource allocation, and program evaluation. Though our results for Aim 2 and 3 did not support their respective hypotheses, given PRAMS' standardized methodology this study can be replicated within other PRAMS sites to aid in the prioritization of preconception wellness in the United States.

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