2018

Assessing Racial Differences in U.S. Prenatal Care, Gestational Weight Gain, and Low Birthweight

Tiffany James
Walden University

Walden University

College of Health Sciences

This is to certify that the doctoral study by

Tiffany James

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Paige Wermuth, Committee Chairperson, Public Health Faculty
Dr. Albert Terrillion, Committee Member, Public Health Faculty
Dr. Michael Furukawa, University Reviewer, Public Health Faculty

Chief Academic Officer
Eric Riedel, Ph.D.

Walden University
2018

Abstract

Assessing Racial Differences in U.S. Prenatal Care, Gestational Weight Gain, and Low Birthweight

by

Tiffany Reneé James

MPH, Walden University, 2014

BS, Norfolk State University, 2007

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Public Health

Walden University

May 2018

Abstract

The benefits of prenatal care (PNC) are extensively documented; however, controversy surrounds the extent to which benefits are experienced among different racial groups. Determining whether PNC influences positive birth outcomes and if advantages differ by race is pertinent to attaining positive health outcomes. The purpose of this study was to examine the relationship between gestational weight gain (GWG), low birthweight (LBW), and PNC while weighing racial differences. The theoretical foundation was the motivation-facilitation theory of PNC access. Research questions were designed to (a) determine if there was a significant association between GWG and LBW, (b) determine if PNC had a mediating role if GWG was found to be associated with LBW, and (c) determine if PNC was a mediator and if that role differed between races. A quantitative, deductive correlational analysis was carried out using a retrospective observational approach. Spearman correlation showed that the relationship between GWG and LBW was significant ($r_s = 0.14$, $p < .001$). Binary logistic regression was used for analysis and showed that the overall model was significant, $\chi^2(12) = 50.29$, $p < .001$, and that maternal age, race, marital status, GWG, education, body mass index (BMI), cigarette use, and gestational diabetes significantly affected the chances of LBW. Baron and Kenny's mediation analysis supported partial mediation for American Indian or Alaskan Native and Asian or Pacific Islander races and showed that PNC was significantly associated with birthweight. Based on these findings, providers can aim to implement motivational factors to increase the facilitation and use of PNC to decrease adverse birth outcomes and increase population health.

Assessing Racial Differences in U.S. Prenatal Care, Gestational Weight Gain, and Low Birthweight

by

Tiffany Reneé James

MPH, Walden University, 2014

BS, Norfolk State University, 2007

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Public Health

Walden University

May 2018

Dedication

This doctoral capstone is dedicated to my late grandmother, Rose, who always instilled confidence in me that I could achieve anything I set my heart to if I let our Lord and Savior guide me. To my wonderful husband, Dorian, who always lifted me up when I felt like quitting, always supportive and understanding, I thank you for speaking life into this journey that we have travelled and assuming my burdens so that I could focus on the finish line. D'Miyah, Dorian, D'yon, Kayden, Kai, and Kaari, my beloved children who loved me unconditionally, even when I felt this process impeded our time spent together, thank you for loving me and providing the smiles and laughter I often needed to get through another day, another course. Lastly, to my mother, Dr. Juanetta Jemison-Morgan, thank you for being the example my sister and I strived to be. Raising my sister and I as a single parent you showed us that regardless of the hand one is dealt in life, success is ultimately up to you. You showed us that each day you get up, get dressed, and get to it regardless of how we felt, as this is what separates successful people from the rest. Thank you for showing us how to love ourselves and succeed in a world that is often unforgiving.

Acknowledgments

I would like to thank my chair, Dr. Paige Wermuth, for her countless hours of dedication to seeing me through this process. Always available and receptive to my many questions and melt-downs, words cannot express my gratitude to you for extending your expertise and imparting of knowledge to help me complete this journey. I am forever grateful to you.

Table of Contents

List of Tables

List of Figures

Section 1: Foundation of the Study and Literature Review

Introduction

Maternal weight gain is a determinant of fetal growth and infant health and can lead to poor health outcomes later in life for the infant (Drehmer, Duncan, Kac, & Schmidt, 2013; Galjaard et al., 2013; Johnson et al., 2013). Studies have shown that appropriate gestational weight gain (GWG) is associated with birthweight and infants' health outcomes (Davis, Hofferth, & Shenassa, 2014; Kristen, 2015; Yan, 2015; Zanardo, Mazza, Parotto, Scambia, & Straface, 2016). According to the Institute of Medicine (2009), the best outcomes for maternal and infant health are achieved within a range of appropriate weight gain during pregnancy. The Institute of Medicine guidelines provide a maternal weight gain range to accommodate women from different ethnic groups as well as those who fall below appropriate height for age (short) classifications. Women with normal prepregnancy body mass index (BMI) are encouraged to gain 37-54 pounds; overweight women, 31-50 pounds; and obese women, 25-42 pounds (Centers for Disease Control and Prevention [CDC], 2015). However, many women in the United States start with prepregnancy overweight or obese BMI classifications (Black, Sacks, Xiang, & Lawrence, 2012). Inappropriate increases in GWG above Institute of Medicine recommendations may lead to macrosomia, perinatal complications, high caesarian section rates, and postnatal adiposity gains (Alberico et al., 2014; Li et al., 2013). Women who start out as underweight and gain below Institute of Medicine guidelines are also prevalent and increase the likelihood of adverse infant health outcomes (Baeten, Bukusi, & Lambe, 2001; Berger, Levitan, Baxter, & Lerner-Geva, 2015; Han, Mulla, Beyene, Liao, & McDonald, 2011; Headen, Mujahid, Cohen, Rehkopf, & Abrams 2015; Johnson et al., 2013; Ray, 2001). However, findings in the literature are inconsistent. Inability to manage appropriate weight gain before or during pregnancy presents potentially severe population health problems for mothers and children (Davis et al., 2014). Low birthweight (LBW) is characteristic of infants weighing 2,500 grams (5.5 pounds) or less and is a primary determinant of infant morbidity and mortality among different races in the United States (Martin, Hamilton, Osterman, Driscoll, & Mathews, 2017). Data showed that in 2014, of the 3,988,076 births, 8.0% were LBW—the same as 2013, but the percent of LBW rose slightly to 8.1% in 2015 (CDC, 2017). Hence, LBW rates did not meet Healthy People 2020 objectives of reducing LBW to 7.8%. In 2014, 23,000 infants died in the United States, and six per 1,000 were the result of LBW (CDC, 2017).

Early and sustained prenatal care (PNC) are pertinent factors in mitigating both adverse maternal and birth outcomes. Early initiation of PNC is care initiated within the first trimester (months 1-3). In 2014, 71% of pregnant women initiated early PNC, below the Healthy People 2020 goal of increasing early initiation of PNC to 77.9% (Mandell & Kormondy, 2015). LBW as a result of inadequate GWG continues to be the leading cause of death among non-Hispanic Black infants (National Research Council, 2010; Mandell & Kormondy, 2015). Furthermore, being underweight during gestation is associated with moderately LBW (1,500-2500g), very LBW <1,500g, intrauterine growth restriction, and shorter mean gestation (Han et al., 2011). LBW infants are at an increased risk of infant mortality and other developmental difficulties in later years (CDC, 2016). Nonetheless, given the inconsistencies in the literature, the Institute of Medicine recommended the need to conduct systematic investigations on the impact of GWG on maternal and child health outcomes (American College of Obstetricians and Gynecologists, 2013). LBW is the result of premature birth or intrauterine growth restriction with maternal health, race, and age being contributing factors (CDC, 2016).

PNC is said to be a protective factor in reducing the risks of LBW, infant mortality, and improving maternal health gains during the gestation and postpartum periods. Inadequate PNC increases the possibility of adverse maternal and infant outcomes, whereas adequate PNC has been an accepted strategy for improving these outcomes (Greenberg, 1983; Krans & Davis, 2012; Showstack, Budetto, & Minkler, 1984; Yeo, Crandell, & Jones-Vessey, 2016). Less understood is the pathway by which PNC affords protective factors to infants across racial and ethnic groups, as non-Hispanic White infants nationally have consistently fared better, even though first-trimester PNC initiation has declined across all races (Healthy People 2020, 2016). Non-Hispanic Black women experienced infant mortality rates more than twice that of other racial groups, had infants that were three times more likely to die from complications related to LBW, and were twice as likely to delay initiation of PNC until the third trimester (CDC, 2015). According to the CDC (2016), only about one-third (32%) of women gained the recommended amount of weight during pregnancy, 21% did not gain a sufficient amount, and 48% gained too much.

PNC has been acknowledged as a means for identifying mothers at risk of delivering growth-restricted infants while providing a range of educational, nutritional, and medical interventions aimed at reducing the risk of LBW and other adverse pregnancy outcomes (Alexander & Korenbrot, 1995; Yeo et al., 2016). However, the controversy surrounding the effectiveness of PNC in preventing LBW stems from the ambiguity in defining PNC and the adequacy of use. Expectant mothers did not meet the 2014 Healthy People 2020 target of having 77.9% of women beginning PNC within the first trimester. Non-Hispanic Black women had the lowest rate of receiving care on time with slightly more than half initiating care within the first trimester, and non-Hispanic White women had the highest rates of compliance (Mandell & Kormondy, 2015). A statement of the problem, the purpose of the study, research questions and hypotheses, the theoretical foundation, and the nature of this study follows.

Problem Statement

Nationally, the incidence of LBW varied from as low of 5.8% of live births in Alaska to more than 10% in the southern states of Louisiana, Alabama, and Mississippi (United Health Foundation, 2017). From 2014 to 2015, the national incidence of LBW remained relatively unchanged (8.0% of live births) with marked disparities by race and ethnicity. Non-Hispanic Black births accounted for 13.2%, non-Hispanic White births 7.0%, and Hispanic births 7.1% (Martin et al., 2017). Nationally, the incidence of LBW did not meet the Healthy People 2020 goal of having less than 7.8% of live birth outcomes be LBW and showed a clear gradient of disparity by race among women who received PNC beginning in the first trimester (Mandell & Kormondy, 2015). Inadequate GWG is a leading factor in LBW outcomes and increased disparities among racial groups (CDC, 2016). Given the controversy that exists in the literature, it is unclear the relationship between maternal birth outcomes among women at a healthy weight versus women who are underweight due to illness or other pathological conditions before and during pregnancy. Despite best efforts to associate teenage pregnancy with higher rates of LBW, data from 2014 showed that teenage birth rates declined in 43 states and Washington, DC for a total decline between 5 and 16%. Therefore, more studies are needed to identify modifying influences of race and age before pregnancy in underweight women and the extent to which prior illnesses account for the observed disparities (Headen et al., 2015; Witt et al., 2014).

Race and age are leading factors in LBW disparities experienced nationally (CDC, 2016). For instance, teenage pregnancy and Black infant health are important in reducing the burden of health inequity and achieving state and national birth outcome-related goals (CDC, 2016; United Health Foundation, 2017). According to 2014 data, the relationship between LBW and maternal age appeared to be modified by maternal race (Hamilton, Martin, & Osterman, 2015). Though the prevalence of LBW infants among non-Hispanic Black and non-Hispanic White teen mothers were similar, the risk of LBW did not decline in non-Hispanic Black women as it did in non-Hispanic-White women. The problem is that race and age have failed to help explain why disparities exist in LBW. As a result, effective intervention strategies to reverse trends in adverse infant health outcomes has not occurred. Inadequate weight gain before and during gestation places infants at an increased risk for LBW, very LBW, and small for gestational age, though the potential causes for very LBW are not clear (American College of Obstetricians and Gynecologists, 2013). Very LBW infants are at a heightened risk of mortality and other health challenges (American College of Obstetricians and

Gynecologists, 2013; CDC, 2016). To date, there has been a lack of articulation of the exact relationship between prepregnancy weight and GWG as determinants of LBW. Most of the existing studies lack data to assess the pathway through which prepregnancy weight and GWG might modify each other in determining birthweight among racial groups in the United States.

Researchers on policy-relevant issues have identified increased access to PNC as vital for improving maternal and child health before, during, and after pregnancy (Johnson, 2012; Roman et al., 2014). However, benefits of PNC appear to be less helpful in improving birth outcomes among non-Hispanic Black mothers as compared to Hispanic and non-Hispanic White mothers (Mandell & Kormondy, 2015). The problem with current birth outcome models and PNC indices are that the value attributed to PNC cannot be determined to be exclusively the result of the association of absence of increased risk because positive birth outcomes cannot be attributed solely to PNC. Optimal age, education, and marital status are cited as protective factors that increases the chance of birthing normal weight infants for women who use PNC services (Clements & Bailey, 2015; Dai, Mao, Luo, & Shen, 2014). For women who forego early and sustained PNC, maternal characteristics such as advanced age, poor education, and marital status may also be contributors to LBW, though the literature has not provided clear evidence that these are not direct contributors of LBW. As the rate of LBW went virtually unchanged from 2013-2014, it is imperative to implement PNC interventions that are geographically specific to reduce the incidence of LBW nationally. Understanding the relationship between trimester of PNC access, maternal weight gains (before pregnancy and the gestational period), and birth outcomes will provide opportunities for improving health gains among different racial groups across the United States.

Purpose of the Study

The purpose of this study was to carry out a quantitative analysis to assess the mediating role of PNC in the relationship between GWG and LBW and determine whether there were significant differences by racial group. Addressing this purpose may aid in providing appropriate counseling needs tailored to different racial groups across the country. This analysis aided in determining if PNC played a mediating role in the relationship between GWG for LBW in the United States.

Research Questions and Hypotheses

RQ1: Is there a significant association between gestational weight gain and low birthweight?

H_0: There is no significant association between gestational weight gain and low birthweight.

H_a: There is a significant association between gestational weight gain and low birthweight.

RQ2: Does prenatal care have a mediating role in the relationship between gestational weight gain and low birthweight?

H_0: Prenatal care does not have a mediating role in the relationship between gestational weight gain and low birthweight.

H_a: Prenatal care does have a mediating role in the relationship between gestational weight gain and low birthweight.

RQ3: Does prenatal care have a mediating role in the relationship between gestational weight gain and low birthweight that differs by racial group?

H_0: Prenatal care does not have a mediating role in the relationship between gestational weight gain and low birthweight that differs by racial group.

H_a: Prenatal care does have a mediating role in the relationship between gestational weight gain and low birthweight that differs by racial group.

Theoretical Foundation for the Study

I used the motivation-facilitation theory of PNC access for this study (Phillippi & Roman, 2013). This theory differs from others aimed at addressing barriers (e.g., access to care), because it helps address individual behaviors that factor into seeking and initiation of care. The motivation-facilitation theory of PNC access is considered a middle-range theory that condenses access to PNC into motivation (i.e., maternal desire to begin and maintain care), and facilitation (i.e., clinical goals to create open access to beneficial, person-centered care) components (Phillippi & Roman, 2013). This theory also differs from others, as it does not treat pregnancy as a sickness or disease of expecting mothers but as motivation for acceptance of pregnancies. Cultural and personal beliefs are factors in expectant mothers' motivation to seek out care. Facilitation is an equally beneficial phase in which clinicians promote and enhance the ability to obtain care (Phillippi & Roman, 2013).

Other theories have been used to highlight barriers of access to care (e.g., the health belief model, Pender's health promotion model, and Khan and Bhardwaj's model of access) but have been minimally effective. Barriers to access are often the result of local phenomena, rooted in geography and culture. In this study, I used the motivation-facilitation theory of PNC access to assess maternal motivation as the main construct by analyzing the month and number of PNC visits recorded. This strategy aided in determining whether there were higher tendencies to seek out PNC based on maternal demographic characteristics. Results from this study may aid in the establishment of policies and interventions to address geographical norms by allowing inference of pregnancy intention of expecting mothers to seek PNC.

The motivation-facilitation theory of PNC access further relates to this study because birth certificate data allowed me to directly assess clinical factors of access while providing a quantification of the effect of these factors to build upon that which existing literature has not been able to explain. As the quality of care often is the focal point in delineating adequacy, the motivation-facilitation theory of PNC access is said to be easier to implement in improving PNC compliance as the theory is less abstract, easily operationalized, and applicable to a variety of subpopulations (Phillippi & Roman, 2013). Theoretical concepts come from Lewin's grand theory of human behavior, which suggests that behavior is a function of the environment and individual (Hall & Lewin, 1936; see Figure 1). The motivation-facilitation theory of PNC access stresses a dynamic interplay and provisioned this study to determine if there was a correlation between initiation and maintenance of PNC and GWG among racial and ethnic groups.

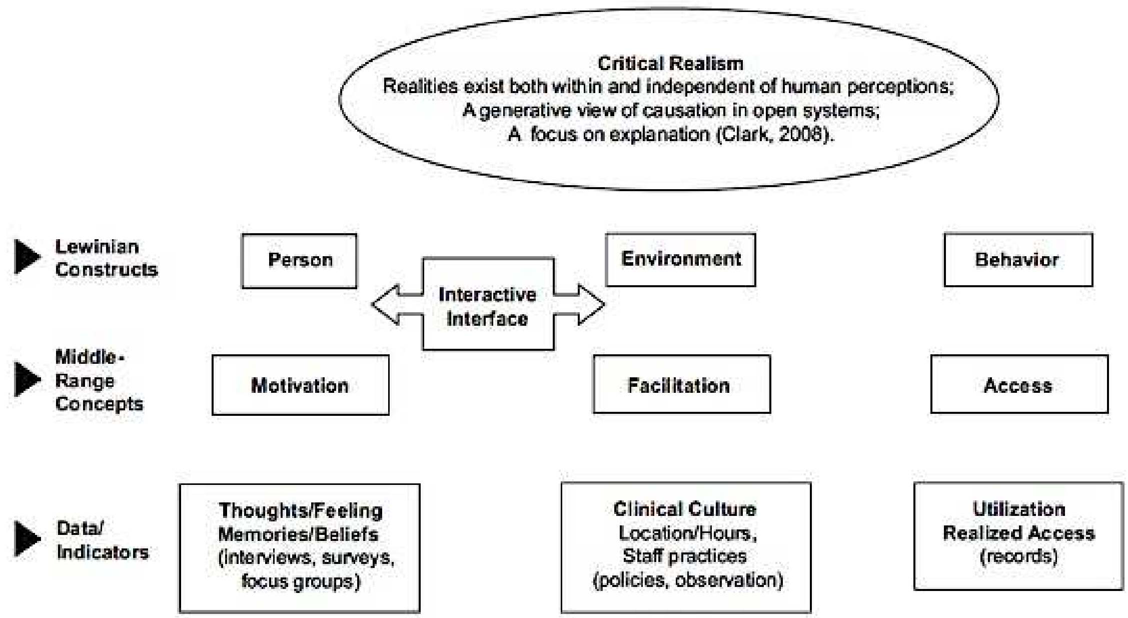

Figure 1. Relationship between Lewin's grand theory of human behavior and the motivation-facilitation theory of prenatal care access. Adapted from "The Motivation-facilitation Theory of Prenatal Care Access," by J. C. Phillippi and M. W. Roman, 2013, *Journal of Midwifery & Women's Health*, *58*(5), p. 509–515.

Nature of the Study

The nature of this study was to present a quantitative research analysis of the relationship between GWG and LBW and whether PNC mediated the relationship. Age, race, maternal education, marital status, body mass index (BMI), tobacco use, and gestational diabetes were possible confounders of this relationship. Focusing on this relationship and the motivation-facilitation theory of PNC access, the results aided in determining the strength of the relationship, providing information to develop interventions at the appropriate levels to reduce LBW disparities experienced nationally. U.S. birth certificate data (2014 natality data) received by the CDC through the Vital

Statistics Cooperative Program from all 50 states was examined to assess the relationship between study variables. Female residents of the United States who had recently given birth made up the sample. Descriptive statistics, correlational analysis, binary logistic regression, and mediation analysis were calculated. Study findings may lead to a reduction in maternal morbidities and subsequent adverse birth outcomes among racial groups in the United States.

Literature Search Strategy

The literature review encompassed a comprehensive exploration of peer-reviewed articles, online library and literature databases, CDC databases, and the Institute of Medicine. Search engines that I used were Academic Search Complete, PLOS, Science Direct, U.S. National Library of Medicine, MEDLINE, BioMed Central, PubMed, and ProQuest. I used the following search terms: *prenatal care access and initiation, gestational weight gain, low birth weight racial disparities, prepregnancy weight, risk factors (hypertension and diabetes), maternal characteristics (educational attainment, age, marital status), Kessner index,* and *the United States*. The literature reviewed were published between the year 1982 to 2017 to account for seminal works focused on the history of PNC in the United States as related to birth outcomes. However, a focus on the most current literature in the field that spanned the past 5 years, 2012 to 2017, illuminated the benefits and controversies that have surrounded PNC access in the United States. Seminal works included literature on the origins and evolution of PNC and birth outcomes. Current peer-reviewed literature was focused on the relationships between PNC access, race, age, and comorbidities. Quantitative as well as qualitative studies were analyzed to provide a complete picture of the magnitude of the controversy surrounding the influence of PNC in producing positive birth outcomes.

Literature Review Related to Key Variables and Concepts

Introduction

This section is focused on relevant literature on relationships among race, LBW, maternal morbidity, and the role of PNC in improving birth outcomes in the United States. Even though PNC is one of the most used preventative care services in the United States, controversy surrounds the efficacy of care regarding different racial and ethnic groups. There are disparities that have been documented in LBW and other maternal and infant health outcomes among different racial groups (Lu & Halfon, 2003; Matthews & MacDorman, 2013; Thomas et al., 2014). There have been many recommendations to improve these disparities, but progress has been minimal (Thomas et al., 2014). Early initiation of PNC, adequacy of care, appropriate GWG as relative to prepregnancy weight, maternal morbidity, and geography are at the center of this controversy. In this study, I reviewed research on these factors in influencing LBW among racial and ethnic groups in the United States.

An Overview of the Controversy Surrounding the Efficacy of Prenatal Care in Mitigating Adverse Birth Outcomes

Maternal weight gains before and during pregnancy and PNC access have been a subject of considerable scholarly and policy debates in the literature (American College of Obstetricians and Gynecologists, 2013; Langford, Joshu, Chang, Myles, & Leet, 2011). Research has shown the benefits of early initiation of PNC in mitigating maternal and infant morbidity and mortality, but the degree of protection remains controversial. Additionally, controversy surrounds the effectiveness of PNC in preventing LBW in different racial groups and the shortfalls of PNC that have existed over the past two decades (Alexander & Korenbrot, 1995; Greenberg, 1983; Krans & Davis, 2012). Part of the debate relates to Barker's hypothesis of developmental origins of adult diseases of fetal origins (Barker, Winter, Osmond, Margetts, & Simmonds, 1989; Barker, Osmond, Simmonds, & Wield, 1993; de Boo & Harding, 2006; Visentin et al., 2014). In this hypothesis, Barker claims that much of adult diseases including hypertensive disorders, heart diseases, diabetes, and other metabolic disorders have their origins in adverse intrauterine fetal environments. Induced changes in fetal physiology and metabolism ultimately increase the risk of diseases in adulthood. This phenomenon, described as fetal programming, is thought to be the main mechanism through which altered changes in the critical periods of fetal environment create irreparable long-term effects in adulthood (Godfrey & Barker, 2001). Maternal nutrition during fetal life is, therefore, a significant marker of diseases in adult life. Thus, LBW infants who survived early mortality were at increased risk of numerous diseases in adulthood. Many studies have supported Barker's claims on conditions of fetal life and adult diseases (Kelishadi, 2014; Visentin et al., 2014), although the contribution of diet-related changes and lifestyle to the incidence of coronary heart diseases and other metabolic disorders has been less recognized (Calkins & Devaskar, 2011). This study was not a test of the hypothesis; however, it served to address how prepregnancy weight of mothers and GWG potentially affected LBW, because these are strong indicators of conditions of the fetal environment and adverse infants' health.

As many chronic diseases have their origins in the early fetal environment, encouraging mothers to receive PNC earlier and adequately before and during pregnancies has been the mainstay of public policies to improve population health (Goldfarb, Smith, Epstein, Burrows, & Wingate, 2017; Heaman et al., 2015). In addition to counseling, PNC provides opportunities to receive pregnancy education on child care and healthy living during pregnancy. Nationally, early initiation and adequacy of PNC have been increasing among racial groups. However, considerable disparities remain that affect maternal weight gain and infant birthweight leading to other weight-related morbidities (Alberico et al., 2014; Li et al., 2013; Mandell & Kormondy, 2015). Adding to the debate is delineating the appropriate weight gain range pregnant women should aim for based on their prepregnancy weight. Many studies have presented different conclusions and associations regarding appropriate weight gain ranges. Some researchers concluded that weight gain outside of Institute of Medicine recommendations serve as a protective factor, whereas others linked GWG deviations to fetal birthweight and other adverse outcomes (Abrams & Selvin, 1995; Davis et al., 2014; Kristen, 2015; MacDorman & Mathews, 2011, 2013; Yan, 2015).

An indication of population health, maternal, and infant health is indicative of the health of the community because adverse birth outcomes typically are linked to other health disparities, morbidities, and mortalities. The Healthy People 2020 objectives to improve the health of women, infants, and families are integral because these factors coupled with fetal programming increase the risk of intergenerational morbidity and mortalities (Drake, 2004; Fox et al., 2015; Healthy People 2020, 2016). It is evident from the literature that racial and ethnic groups have not benefited equally from social and medical advances, and the role of PNC in mitigating adverse birth outcomes is less clear across these groups (Zhang, Cardarelli, Shim, Booker, & Rust, 2013). The literature review was focused on the evolution of PNC, controversies related to discrepancies in PNC indices used in birth outcome models—for example, the Kessner index, GINDEX, and the adequacy of prenatal care utilization, racial disparities that exist in PNC access, appropriate GWG ranges, and the role of geography.

Overview of Low Birthweight in the United States

In the United States, there were approximately 318,847 infants born with LBW (< 2,500 grams), amassing to 8% of live births, which did not meet the Healthy People 2020 target of having less than 7.8% of live births weigh below 2,500 grams in 2014 (CDC, 2016). Premature birth and restricted fetal growth are the two most common causes of LBW. However, prematurity in the United States has steadily declined while LBW has remained steady, suggesting that there are other factors (Martin, Hamilton, Osterman, Curtin, & Mathews, 2015). In 2014, LBW infants were most common among non-Hispanic Black mothers with a prevalence of 13.6%, above the national average of 8.0% (Martin et al., 2015). Infants born with LBW are at an increased probability of suffering short- and long-term disabilities such as infection, delayed motor and social developments, asthma, diabetes, hypertension, and higher mortality risk during the first year of life (CDC, 2016).

Within the United States, LBW was the second leading cause of infant death (104.6 per 100,000), only behind congenital malformations at 119.0 per 100,000 (Murphy, Kochanek, Xu, & Arias, 2015). The causes of LBW and premature birth often overlap, which are critical to clinical characteristics. In 2014, 1 in 12 infants was LBW (National Center for Health Statistics, 2017). In a measure of population-level health non-Hispanic Black infants experienced infant mortality rates more than twice that of other racial and ethnic groups. Literature has supported PNC as being a mediator in reversing infant mortality rates experienced by this group. Congenital malformations and LBW are two conditions proven to be positively impacted by PNC with the most important influencing factor for neonatal infant mortality rates being birthweight (CDC, 2016).

An estimated 50% of infant deaths were deemed preventable with a critical element being the prevention of LBW. Prevention efforts include early initiation of PNC and providing educational information on nutrition-related and behavioral risk factors (CDC, 2016). Healthy People 2020 set a target of having at least 77.9% of women initiate PNC within the first trimester; the problem is that early initiation of PNC has not been proven to be fully beneficial in reducing racial disparities in birth outcomes. A discussion of the evolution of PNC follows.

The Evolution of Prenatal Care and Utilization Indices

PNC was first proposed by Ballantyne in the 20th century as a method of providing organized care to pregnant women that initially focused on the prevention of fetal abnormalities and was later amended to include neonatal, fetal, and maternal deaths (Ballantyne, 1905, 1901). Concerns surrounding maternal morbidity and mortality—for example, eclampsia and toxemia (hypertension)—initially shaped the content of PNC in the United States and aided in the establishment of appropriate parameters for the timing and frequency of doctor visits (Schechter, 1991; Taussig, 1937). Many present-day PNC practices and protocols have origins rooted in early PNC. For example, PNC protocols began integrating urine tests and serial blood readings protocols due to associations between eclampsia and the presence of albumin in urine and hypertension (Alexander & Kotelchuck, 2001). During the 1900s PNC structure, quality and content underwent many changes that have shaped the controversy surrounding the intended outcomes, shifting focus to LBW and other preventable conditions that contribute to infant mortality rates (Krans & Davis, 2014). Institute of Medicine committee members challenged public and private sector leaders in 1985 to design a maternity care system that would attract women from all racial and socioeconomic backgrounds to help shape appropriate social and health services throughout pregnancy and the postpartum periods. PNC indices became common integrations in birth outcome models, employed to aid in the analysis of the relationship between adequacy of care, LBW, preterm births, and infant mortality rates (VanderWeele, Lantos, Siddique, & Lauderdale, 2009). PNC use indices, though applied to infer an association between adequacy of PNC and birth outcomes, are often at the center of this controversy as there is a lack of standardization of measures used to define adequacy of care. The Kessner index, the adequacy of PNC utilization, and the GINDEX are commonly used indices to assess performance in birth outcome models, though their efficacy has been debated.

The Kessner index. Published in 1973 and based on American College of

Obstetricians and Gynecologists (ACOG) recommendations regarding the number of PNC visits, the Kessner index was once the primary PNC utilization index (VanderWeele et al., 2009). This index provides information about the timing of PNC initiation and follow-up visits, and was first published as part of an infant mortality study supported by the Institute of Medicine (VanderWeele et al., 2009). This index allows for a continuous numeric measurement by taking the month that PNC began, the total number of visits, and adjusting for gestation length (Kotelchuck, 1994; VanderWeele et al., 2009). An index comprised of three levels of adequacy (adequate, intermediate, and inadequate) was then linked with this measurement. The algorithm for this index rates PNC as adequate if care began in the first trimester and there were nine prenatal visits over the course of a full-term pregnancy; care is rated inadequate if PNC began in the third trimester or if the total number of visits for gestational age at birth fell beneath a given threshold. Kotelchuck (1994) formerly referred to this index as the “adequacy of prenatal care index.” This naming convention added to the controversy of its use in birth outcome models because concluding the efficacy of care was not possible because the measure could not be used to indicate content or clinical adequacy of care and served merely as a utilization index (Kotelchuck, 1994). Other early issues with this index surrounded the notion that delivery by a private obstetrician was a requirement for an “adequate” rating (Kotelchuck, 1994). Noting the need for refinement, Alexander and Cornely (1986) proposed the inclusion of a 6-category index that included no care, missing, and intensive categories in addition to the original three, which informed the GINDEX index.

GINDEX index. The inclusion of an *intensive* category marked a pertinent development in addressing issues that plagued the Kessner index. Including an *intensive* category allowed for the separation of high-risk pregnancies from the *adequate* category, which often resulted in elevated numbers of PNC visits (Koroukian & Rimm, 2002). Including a *high-risk* category to the GINDEX index was appropriate because combining them with pregnancies classified as *adequate* often resulted in obscured study results. Separation of these groups was integral to distinguish these different risks, though the Kessner index assessed them together. Alexander and Cornely (1986) referred to this revision as the GINDEX index, which used the American College of Obstetricians and Gynecologists recommendations to determine the number of PNC visits for an adequate rating. The GINDEX index differed in that the threshold did not truncate at nine visits (Alexander & Cornely, 1986; Harris, 1982). There was also a clear delineation between *missing*, *no care*, and *inadequate* categories, which were important in analyzing birth outcomes because when visits exceeded one or more standard deviations above the mean, cases were categorized as *intensive* (VanderWeele et al., 2009). Because the GINDEX index was still claimed ineffective and inconsistent in associating birth outcomes, Kotelchuck (1994) proposed the adequacy of PNC utilization index, which also included an *intensive* or *adequate-plus* category.

The adequacy of prenatal care utilization. Kotelchuck's adequacy of PNC utilization included either an *adequate-plus* or *intensive* category (Kotelchuck, 1994). This PNC index differed from the GINDEX because it was not based on the trimester PNC began, and adequacy was broken down into two separate indices and allowed for a more refined differentiation of PNC initiation by dividing the adequacy category into 2-

month intervals as opposed to trimesters. The GINDEX index was used to compare visit quantity between PNC initiation and delivery to the American College of Obstetricians and Gynecologists recommendations (VanderWeele et al., 2009). A ratio greater than 1.1 is considered *adequate-plus*; 0.8-1.1, as *adequate*; 0.5-0.8, as *intermediate*; and less than 0.5 as *inadequate* (VanderWeele et al., 2009). The adequacy of prenatal care utilization index, considered the standard, has also been met with criticism because there are inherent biases that can affect the conclusions drawn about birth outcomes if use is outside of the capability and scope of the index.

Biases of indices. The adequacy of prenatal care utilization index is considered the standard, being included in recent studies and used mainly by the National Center for Health Statistics (Avci, Col, Yavuz, & Yilmaz, 2016; Bediako, BeLue, & Hillemeier, 2015; Tayebi, Zahrani, & Mohammadpour, 2013). The standardization of this index has received substantial criticism, because in the case of shorter gestational ages and prematurity, misclassification can lead to biased study results when expected visits are more than one. Also, the adequacy of prenatal care utilization index should not be used to study associations between LBW and PNC use, because an analysis stratified by gestational age may be better suited (Koroukian & Rimm, 2002). The GINDEX index has been shown to suggest that birth outcomes are better in the *inadequate*, *intermediat*e, and *intensive* categories as compared to those classified as *adequate* (VanderWeele et al., 2009). Another common criticism is that PNC use indices are not useful because they do not reveal anything about the content or adequacy of clinical care administered, and conclusions should be accepted with caution because the PNC/birth outcome association is sensitive to the index that was used (Kotelchuck, 1994).

Disadvantages of the Kessner index are time and distinction of categories. The Kessner index is merely a measure of time, which unveils the trimester in which PNC began. An *adequate* rating entails PNC that started in the first trimester; *intermediate* indicates PNC that started in the second trimester; and *inadequate* indicates that PNC began in the third trimester or not at all (Kotelchuck, 1994). There is also a lack of distinction between inadequate care resulting from late initiation versus why differences exist in inadequacy due to insufficiency in the number of visits. This lack of distinction could lead to misclassification in the absence of a subscale. The Kessner index is also unable to differentiate between post mature and normal-gestation births (Kotelchuck, 1994). Aside from the issues associated with the use of PNC indices, the efficacy of early initiation of PNC has also been controversial.

Arguments for and Against the Efficacy of Early Initiation of Prenatal Care Access

Early initiation of PNC has been associated with positive birth outcomes, whereas opposition argues that it is the quality of PNC received that positively affects birth outcomes and not the timing of care. There is a gradient in PNC use and initiation by race, though the reasons are not clear. What is known is that factors that affect initiation vary by local context and factors that promote and present as barriers and motivators influence timing (Heaman et al., 2015). Current and past literature show early and consistent PNC visits to be an accepted strategy in improving maternal and infant birth outcomes to include reducing the occurrence of LBW infants (Committee to Study the

Prevention of Low Birthweight, Division of Health Promotion and Disease Prevention, & Institute of Medicine, 1985; Gortmaker, 1979; Roman, Raffo, Zhu, & Meghea, 2014).

Improvements in birth outcomes linked to first-trimester PNC initiation are screenings, education, early diagnosis of chromosomal and structural anomalies, cell-free fetal DNA that screens for fetal aneuploidy, pregnancy complications such as LBW, macrosomia, small for gestational age, and gestational diabetes (Sonek, Kagan, & Nicolaides, 2016). There is also evidence that adverse health and birth outcomes can be minimized in the event screenings and treatment are implemented early (Sharp & Alfirevic, 2014). Approximately 50% of severe fetal anomalies are diagnosable before 14 weeks of gestation (Van Mieghem, Hindryckx, & Van Calsteren, 2015). Fetuses of obese women become challenging to screen at mid-trimester screenings (Jeve, Konje, & Doshani, 2015; Martin, Krishna, Ellis, Paccione, & Badell, 2014). Thus, data supports the need for early initiation of care.

Maternal characteristics such as marriage, higher educational attainment, and socioeconomic status have been associated with maternal motivation to seek PNC. Women who fared better in these measurements were inclined to eat more nutritional meals, exercise, maintain proper weight, and were more likely to seek out PNC, casting doubt that PNC solely influenced positive birth outcomes (Krans & Davis, 2012). Arguments also center upon appropriate weight gain based on Institute of Medicine standards and the effects of prepregnancy weight status.

Arguments Against Early Initiation of Prenatal Care Access

The health belief model has been widely used in concert with birth outcome models. The health belief model has been ineffective in aiding in the implementation of effective health planning projects aimed at reducing racial disparities experienced in PNC access and birth outcomes (Phillippi & Roman, 2013). Phillippi and Roman (2013) suggested this occurrence is the result of the health belief model and other theoretical models treating pregnancy as an illness, whereas it is not. Barriers often change with local context rendering the assessment of barriers minimally useful in the absence of consideration of local phenomena. Thus, assessing motivation as the driving force behind seeking early and sustained care is needed (Phillippi & Roman, 2013). The problem is that empirical evidence is absent from randomized controlled trials to aid in establishing the benefits of PNC, or what frequency and content of care have the maximal benefit (Partridge et al., 2012). Several studies in the late 1970s and early 1980s found a significant association between "no" PNC and the incidence of LBW, though none accounted for gestational age bias (Eisner et al., 1979; Greenberg, 1983; Taffel, 1978).

Evidence supports an association between not only excessive GWG, increased birthweight, and postpartum weight retention, but insufficient weight gain and decreased birthweight as well (Blomberg, 2011; Siega-Riz et al., 2006). Studies have revealed ambiguities in the impact of maternal weight gain on infant mortality. Some results have shown that inadequate GWG increases the risk of infant mortality, while others have shown that excessive weight gain appear to be a protective factor; and still others concluded that specific patterns of GWG during the 2nd trimester are related to fetal birthweight (Davis et al., 2014; Abrams & Selvin, 1995). Drehmer et al., (2013) looked at maternal weight gain during the 2nd and third trimesters according to Institute of Medicine recommendations and found that insufficient weight gain in the 3rd trimester was not associated with adverse outcomes, though other deviations from recommended weight gain were. MacDorman and Mathews (2011) and (2013), assessed associations of infant mortality from the period of 2005-2008 and noted that regarding access and quality of care there were considerable disparities by race and Hispanic origin and that all groups had not benefited equally from social and medical advances. Recent evidence also supported the stance that factors such as Black race, gestational hypertension, and advanced maternal age were significantly associated with LBW, regardless of inadequate or adequate PNC (Xaverius, Alman, Holtz, & Yarber, 2016).

The problem resides in determining if PNC is a mediator and whether there is an association between PNC initiation and frequency, GWG, and LBW during the perinatal period in the U.S. Controversy also surrounds the methodologies used in exploring the effectiveness of PNC.

Strengths and Weaknesses of Methodology Employed in the Field

Researchers in the field have employed various methodologies to aid in explaining the disparities that persist in early initiation and utilization of PNC. Quantitative methods that utilized observational methods to analyze secondary data have been advantageous in delineating the different rates of use among racial/ethnic groups while offering extensive, reliable, representative samples (CDC, 2017). However, one disadvantage is that these methods have done little to explain why disparities persist as PNC use does not determine the quality of care. Likewise, using birth certificate data from the National Vital Statistics System (NVSS) is widespread among researchers in the field. Advantages include identification of women and infants that are high risk for health problems, monitoring of changes to health status, measurement of goals towards health improvement, and investigation of emerging issues by state and local governments to aid in planning and reviewing of program policies (CDC, 2017). Another strength in utilizing population-based data is that it allows researchers to employ quantitative, qualitative, or mixed-methods designs to provide complementary information to address the issue from a holistic point of view.

Arguments against early initiation of PNC access are equally widespread and often thrust into the spotlight the need for a birth outcome model that measures the adequacy of care as opposed to timing. Recent literature has noted that disparities in care have shifted towards the quality of care, as opposed to access as previously postulated (Muoto, Luck, Yoon, Bernell, & Snowden, 2016). This conclusion highlight how state and federal policies have led to an increase in early initiation of care and identification of disparities related to differences in insurance type; though they have not been effective in increasing PNC adequacy. Opponents of PNC advise caution in over-interpreting 1st-trimester findings as false-positive rates of 3-4% have been reported, and could potentially improve with time (Van Mieghem et al., 2015). Furthermore, though PNC became an established standard of practice, standardization was in the absence of conducting randomized clinical trials to determine the efficacy of each constituent (Alexander & Korenbrot, 1995). Given the standards that guide human research and classification of pregnant women as a vulnerable group, today's research parameters will deem separation of women into adequate and inadequate groups unethical, making it difficult to control for selection bias. The effectiveness of PNC in influencing GWG is another point of controversy.

Gestational Weight Gain Controversy

Appropriate GWG ranges for pregnant women has undergone a dramatic shift and is often at the center of the controversy surrounding the efficacy of PNC in mitigating weight gain. For over two decades, GWG and its relation to adverse birth outcomes were dictated by Institute of Medicine standards. Women with a normal prepregnancy body mass index (BMI) were recommended to aim at gaining 37-54 pounds; overweight women, 31-50 pounds; and obese women, 25-42 pounds (CDC, 2015). As research shaped and informed practice, a greater diversity of women had babies, teen pregnancy declined, and more women entered pregnancy as overweight or obese (CDC, 2015; Martin et al., 2015; Siega-Riz & Laraia, 2006; Nohr et al., 2008). As a result, the World Health Organization (WHO) reexamined and updated 1990 Institute of Medicine guidelines (American College of Obstetricians and Gynecologists, 2013).

Updated guidelines recommended underweight women gain 28-40 pounds; normal weight women, 25-35 pounds; overweight women, 15-25 pounds; and obese women 11-20 pounds. Practitioners have been hesitant to implement updated guidelines as they feared the impact of excessive weight gain (Alberico et al., 2014; American College of Obstetricians and Gynecologists, 2013; Black et al., 2012; Li et al., 2013). Literature has shown both positive and negative outcomes utilizing both guidelines. As

PNC has been minimally effective in reducing LBW race disparities, controversy also surrounds its usefulness in reducing gaps experienced between racial and ethnic groups.

Effectiveness of Prenatal Care in Reducing Low Birthweight and Race Disparities

LBW can be defined as newborns born weighing less than 2500 grams and can result from preterm birth, or intrauterine growth restriction (CDC, 2016). There are stark differences in the proportion of LBW infants between different racial groups. Non-Hispanic Black infants consistently perform worse with rates more than double that of any other group over the past two decades, while non-Hispanic white infants have had the lowest rates of LBW than any other racial group (CDC, 2015; National Center for Health Statistics, 2017). Current literature suggests that pregnancy intendedness, education, socioeconomic status, location, and provider availability serve as motivating factors. These factors aid in the facilitation of seeking PNC, which may exert an influence that is independent of PNC (Heaman et al., 2015a; Krans & Davis, 2012; Lindberg, Maddow-Zimet, Kost, & Lincoln, 2015). Non-Hispanic Black women remain the unhealthiest group, have lower socioeconomic statuses, and suffer from higher rates of diabetes, hypertension, obesity, and other co-morbidities (Noonan, Velasco-Mondragon, & Wagner, 2016). Both proponents and opponents of the efficacy of PNC postulate that these factors, independent of PNC are what has rendered PNC ineffective in mitigating racial disparities in birth outcomes, in addition to affecting motivation to seek care.

Geography

Geographic makeup is another factor that affects initiation and sustainment of PNC. According to the American College of Obstetricians and Gynecologists, rural (nonmetropolitan) women are more likely to experience poor health, not receive preventive screening services, and have lower rates of PNC initiation in the first trimester as compared to their urban (metropolitan) counterparts (American College of Obstetricians and Gynecologists, 2013). As a result, nonmetropolitan women were more likely to experience higher rates of hospitalizations, pregnancy-related complications, and adverse birth outcomes such as LBW (American College of Obstetricians and Gynecologists, 2013; Hillemeier, Weisman, Chase, & Dyer, 2007). According to U.S. census data collected between 2011-2015 rural areas covered 97% of the nation's land, and contained 19.3% of the population (approximately 60 million people). Data showed that adults in rural areas had (a) a higher median age, (b) lower rates of poverty (11.7% compared to 14%), and (c) were less likely to graduate college (19.5% compared to 29%) (United States Census Bureau, 2016). Understanding the effects of geography on PNC initiation is important because it supports the need for assessment of barriers and motivators that are area-specific. In a recent study by Shoff, Yang, and Matthews (2012), geographically weighted regression was used to examine the relationship between PNC and geography in the U.S. to determine areas of low PNC utilization by location. Results showed there was a significant association between the percentage of the uninsured population and the percentage of women receiving late or no PNC. Results also revealed a positive association between the number of obstetrician and gynecological doctors per 100,000 women of child-bearing age and the percentage of women who received late or no PNC. Focusing on barriers to care such as lack of family support and child care, and transportation has not aided in reducing the racial disparities experienced among racial groups nationally. Focusing on facilitators of PNC such as increasing providers, decreasing health services barriers (e.g., decreasing distance, visits and long waits) can aid in making PNC more accessible and convenient (Heaman et al., 2015).

Definitions

Prenatal care: Prenatal care is a dynamic, clinically provisioned comprehensive approach to health care provided to expectant mothers during pregnancy (Alexander & Kotelchuck, 2001). Care is inclusive of routine visits combined with ancillary services that may involve outreach services, health/promotion education, counseling, social support, transportation and so on with the intended outcome of positively impacting maternal, fetal, and infant health outcomes (Alexander & Kotelchuck, 2001).

Inadequate prenatal care: Inadequate prenatal care is defined as late initiation of care, not meeting the specified number of visits, or no prenatal care at all (Alexander & Kotelchuck,1996; VanderWeele et al., 2009).

Birthweight, low birthweight, and very-low birthweight: Birth weight is the initial weight of infants as measured immediately after birth. Infants born with low birthweight (LBW) are characterized as weighing less than 2500 grams, while VLBW infants weigh less than 1500 grams at birth (Dai et al., 2014).

Gestational weight gain (maternal weight gain): Gestational weight gain is the exact weight gain of women during pregnancy. This term is often used interchangeably with maternal weight gain and as a calculation of when prenatal care was received (Deputy, Sharma, & Kim, 2015).

Kessner index: The Kessner index is a measure of prenatal care adequacy which aims to associate adequacy of care based on maternal utilization. Also, referred to in the literature as the adequacy of prenatal care index, this index considers both PNC initiation as well as the periods following initiation (Kotelchuck, 1994). Originally published as part of an Institute of Medicine-supported study in 1973, this index contained continuous numeric measures (e.g., month prenatal care began, and total visits) linked to three levels of adequacy (adequate, intermediate, and inadequate) (Kotelchuck, 1994).

Body mass index (BMI): Body mass index is a categorical classification of body fat measures based upon a height to weight ratio in adult women and men as established by the National Institutes of Health. Individuals with a BMI < 18.5 are considered underweight; 18.5-24.9, normal; 25-29.9, overweight; and 30+, obese (The American College of Obstetricians and Gynecologists, 2013; Yu et al., 2013). BMI was calculated based on maternal prepregnancy weight and height as follows (National Center for Health Statistics, 2017):

$$[\text{mother's prepregnancy weight (lb)} / [\text{mother's height (in)}]^2] \times 703$$

Race/ethnicity: The race/ethnicity reported defines that of the mother. 2014 natality data consisted of bridged maternal race categories to include: non-Hispanic White, non-Hispanic Black, American Indian or Alaskan Native, and Asian or Pacific Islander (National Center for Health Statistics, 2017). Non-Hispanic Black referred to women who identified as Black or African-American and not Hispanic, while non-Hispanic White referred to women who identified as White or Caucasian, but not Hispanic. Hispanic classifications occurred for women who identified as Hispanic regardless of race description. The “other” category contained women who did not identify with the other races; nor self-identified as Hispanic (Mandell & Kormondy, 2015).

Assumptions

Disparities in PNC use differ by race. The issue is that race does not explain why disparities in PNC use and adverse birth outcomes persist. Whereas this study quantified the magnitude of the issue between PNC and worst outcomes among racial groups, it did not definitively prove that race, as opposed to cultural, geographical, societal, or local norms, were not influencing factors. Also, one early assumption of the Kessner index of prenatal care adequacy is that care received from public services could not be adequate (Kotelchuck, 1994). This assumption is controversial as use of this index does not suggest anything about the content of care, which is critical in considering adequacy, but provides only a numerical representation of use (Alexander & Kotelchuck, 1996; Murray & Bernfield, 1988). Therefore, even though the literature suggests an association between early initiation of care and better birth outcomes, this study cannot solely back this association, in the absence of other psychosocial factors. This assumption was necessary to the context of this study because the use of PNC indices is widespread in drawing birth outcome related associations, although they have been found to be imperfect and have led to erroneous conclusions. There has also been a lack of randomized clinical trials as separation of expecting mothers into adequate and inadequate groups is unethical (VanderWeele, Lantos, Siddique, & Lauderdale, 2009). However, currently these indices are the only means available to associate birth outcomes with PNC use.

Scope and Delimitations

The research problem aimed to determine whether there was an association between PNC initiation and use that differed between racial groups in the United States. This focus was chosen because non-Hispanic Black women had the lowest rates of PNC use and initiation. As such, policy and interventions have been ineffective in reducing adverse birth outcome disparities nationally. This study revealed current associations between PNC, GWG, LBW, and potential confounders. Analysis of vital statistics data allowed for the assessment of participant responses and hospital records, which were assumed to be truthful and factual according to the respondents' recollection of events. Internal validity seeks to attribute better birth outcomes among racial groups to PNC use and initiation. However, because there was an absence of data to assess intendedness, it is beyond the scope of this study to solely contribute better birth outcomes to PNC initiation and use, thus highlighting the importance of the motivation-facilitation theory of prenatal care access in providing an alternative explanation for the outcome.

Delimitations

Birth data was limited to only those that occurred within and to residents of the United States. Birth data for infants born to nonresidents were excluded. Traditionally used theories such as the health belief model were omitted as this study utilized the motivation-facilitation theory of prenatal care access as a framework which considered motivating factors that influenced seeking PNC as opposed to barriers. The use of traditional theories has not been successful in explaining the relationship between PNC, GWG, and LBW; nor successful in informing practice conducive to implementing interventions and policies that have been successful in addressing the racial disparities that exist. This method is potentially problematic as there was a risk of misinterpreting data or incorrectly categorizing pregnancy intention (Phillippi & Roman, 2013). Vital statistics data represented a true measure of the population. Over-sampling and stratifying sub-populations increase chances that the sample is generalizable to the population (National Center for Health Statistics, 2017).

Significance, Summary, and Conclusions

Significance

In the United States., there is a disproportionate burden of adverse health outcomes experienced amongst racial groups. The identification of women at high risk of inadequate weight gain at the onset of pregnancy is pertinent for policy and public health interventions. This study may serve to provide national-level risk factors to assess the potential impact of inadequate GWG on LBW. More specifically, the results of this study can potentially provide a unique opportunity to tailor preconception counseling to underweight women on the potential risks to them and their infants' health. The results of this study may aid in decreasing health disparities in the Black community by targeting interventions to improve maternal health before pregnancy, during gestation and the postpartum period. This study may also lead to identification of incentives for continuing education for providers, staff, and expectant mothers. Lastly, uptake of positive behaviors could lead to early and sustained PNC.

The United States government and the World Health Organization (WHO) have a policy goal of reducing health disparities in LBW and very LBW outcomes in the country

(CDC, 2017). In response, numerous social intervention programs including increased access to PNC are in place to encourage mothers to seek early PNC. This study may lead to understanding risks associated with prepregnancy weight status and GWG on LBW and other birth outcomes. Identification of these risks may support the development of specific state policies and public health interventions aimed at improving prenatal counseling needs among new and expecting mothers.

Social change is improving the quality of life by reducing disparities through the imparting of knowledge that influence the uptake of positive behaviors. It is through these behaviors that health status is impacted through the establishment and implementation of socially acceptable norms, acts, and traditions that expand beyond the individual to the community in a participatory manner. This study may advance Walden's mission of social change by affecting change at the individual, community, and societal levels. This study promoted social change to reduce disparities in LBW among expectant mothers in the United States by potentially informing policy and interventions tailored to address differences among PNC compliance. Fostering compliance will also ensure that interventions are culturally sensitive and appropriate to bring about desired changes. Health equity is to ensure the optimal health, and removal of barriers that are unnecessary, unavoidable, unfair, and unjust towards the advancement of health (Marmot & Allen, 2014). This study aided in recognizing systematic barriers and traditional practices that have been prevalent. Thus, health equity may be more attainable as individuals increase their uptake of positive behaviors and increase PNC compliance while decreasing negative behaviors (e.g., tobacco and alcohol use, inadequate nutritional intake, and stress) thus minimizing the disparity gap experienced amongst the racial groups.

Summary and Conclusions

The attempt to solely relate PNC use to better birth is an imperfect approach. The current PNC indices lack standardization and report different conclusions based on the birth outcome under study (Alexander & Kotelchuck, 1996). Inclusion of PNC indices in birth outcome models is also controversial because they do not provide information on the adequacy or content of care, but measure only the timing and frequency of care. The literature suggests there is a significant association between PNC and positive birth outcomes, though empirical evidence does not rule out confounders such as education, pregnancy intent, and other external motivators in the initiation and sustainment of PNC. As racial disparities continue to persist in PNC access and use, policies and interventions have not led to significant decreases in adverse birth outcomes. Changes in American College of Obstetricians and Gynecologists weight gain ranges have further led to controversy as some providers do not agree with the new recommendations, and past and recent studies have shown that weight gain outside of the American College of Obstetricians and Gynecologists recommendations does not always lead to adverse birth outcomes (Abrams & Selvin, 1995; Davis et al., 2014). Given the inconsistencies in adverse birth outcomes based on American College of Obstetricians and Gynecologists recommendations, research should aim to evaluate the efficacy of a revised guideline. The traditional approach to policy and intervention has been to address barriers to access, though this method has not been successful in reversing LBW trends experienced by minority groups. What is not known is the effectiveness of external motivators in mitigating adverse birth outcomes, nor the extent to which PNC is effective. This study sought to determine if there was a significant association between PNC, GWG, and LBW in the presence of confounding factors.

Section 2: Research Design and Data Collection

Introduction

The purpose of this study was to assess associations among GWG, LBW, and PNC access among new mothers who were residents of and had given birth to live infants in the United States in 2014. Analysis also provided an in-depth understanding of interrelated factors linked to race, age, and maternal morbidity. These factors are pertinent in tailoring counseling needs to different racial groups. In this section, I will describe the research design and rationale, methodology (i.e., population, sampling and sampling procedures, instrumentation and operationalization of constructs), threats to validity, and ethical procedures.

Research Design and Rationale

PNC (independent exposure variable), maternal GWG (independent outcome variable), and LBW (dependent outcome variables) were the primary study variables for this study. I conducted a quantitative, deductive correlational analysis using 2014 national birth certificate data. This approach aided in the quantification of behaviors, which allowed me to make conclusions about the relationship between PNC use and maternal and birth outcomes. A quantitative analysis was appropriate in addressing the purpose of the study because it allowed for investigation of the relationship between GWG and LBW in determining whether PNC was a mediating variable in the relationship among new mothers in the United States. This design was also appropriate because it allowed me to evaluate the research questions and determine whether there was a statistically significant association between the study variables in the presence of and independent of mediating variables and potential covariates. Further, this design allowed for generalization to the population in establishing magnitude, prevalence, and incidence of adverse infant birth outcomes. A qualitative approach would have taken on a more narrative form with the goal being to examine perspectives, beliefs, and culture and how they informed the behaviors of study participants, which was inappropriate for this study (Creswell, 2009). There were no time or resource constraints associated with the chosen design.

As pregnant women, fetuses, and infants represent vulnerable populations, research involving these entities hold ethical research practices in the highest regard. Astute attention during the design and recruitment phases is pertinent and scrutiny measurements regarding safety and efficacy strategies are paramount because ethical dilemmas frequently arise regarding data privacy, therapeutic deliberations, and communication (Blehar, Spong, Grady, Goldkind, Sahin, & Clayton, 2013; Shivayogi, 2013). Hence, my study design was a retrospective analysis of data collected from these vulnerable groups and was consistent with current and past research in the field because it did not require direct manipulation of human participants but allowed for analysis of a broad array of data related to maternal and infant behaviors and health. This study highlights the importance of assessing motivational and facilitation factors as opposed to barriers, which has proven minimally effective in reversing adverse birth outcomes.

Binary logistic regression analysis was used to assess the likelihood of a LBW outcome while accounting for confounding effects of variables associated with racial groups. Models for this analysis applied stepwise procedures using a P-value of $< .05$

from the stratified analysis. This study used a level of significance of less than 5% in all analyses with Stata version 14.1 software for all calculations.

Methodology

Population

The sample consisted of female residents of the United States who had recently given birth to LBW infants within the United States. In 2014, there were a total of 3,988,076 live births in the United States of which 8% were LBW (CDC, 2017). Birth certificate data were extracted making available medical and demographic information through state vital records systems.

Sampling and Sampling Procedures

Random variation and confidence intervals. Based on a complete count, 2014 data from all registered birth certificates in all states and Washington, DC were based on population estimates from 2010 census data and based on sex, race, and age census counts as provided by the U.S. Census Bureau. The number of births reported for each area was considered a complete count and was not subject to sampling error, though nonsampling errors such as mistakes in recording during the registration process were possible. A stratified random sampling technique was employed to randomly select 1,104 women from four racial groups (i.e., non-Hispanic White, non-Hispanic Black, American Indian or Alaskan Native, and Asian or Pacific Islander). The confidence interval (CI) represented the range of values for which births, percentages of births, and birth rates one can expect 95 out of 100 cases to fall. Confidence limits also revealed expected variation under the same or similar circumstances. Thus, the CI estimates from an actual number of vital statistics events for percent, numbers, and rates were possible. Statistical significance was pertinent because it revealed whether the probability of observed differences was due to chance. When *p* values exceeded an alpha level of .05, commonly used in the field, it was assumed that those differences were the result of sampling variability.

Sample size. A 95% confidence level and interval were used to foster a 95% probability of containing the true population interval, which also provided information about the margin of error of the estimate, consistent with CDC standards for reporting upper and lower confidence limits (CDC, 2017).

As the number of vital events under consideration in this study (live births) in all reporting areas was considered large (more than 100), distribution was assumed to be normal, equating to a small standard error in participating states. In 2014, there were 3,988,076 births, of which 8% (319,046) were LBW. The following information was needed to calculate the sample size (Roopesh, 2014):

p: prevalence of LBW, which was 8% in 2014

q: (100 – p), which equates to 92

d: the relative precision of the estimate

Z_a: 1.96, obtained from probability table for normally distributed values, with a standard error of 2.

With *p* being equal to 8% the relative precision *d* was (8/100) * 20 = 1.6. As a result, detection of a *p* of 7.2 or more with half of the value of precision (0.8) on either side of *p* ($p >$ +/- 0.8%; 7.2 to 8.8) was possible. Therefore, by using a precision of 20% of *p* (1.6), I should have been able to determine the true awareness level given the actual prevalence was 7.2% or more. However, if the actual prevalence was less than 7.2%, I would have been unable to make an accurate determination. The formula for calculating sample size was as follows:

$$N = \frac{(Za)^2[p*q]}{d^2}$$

$$= \frac{(1.96)^2[8*92]}{1.6^2} = 1104 \text{ per racial group}$$

A sample size of $N = 1{,}104$, per racial group ($N = 4{,}416$), enabled detection of the truth as the prevalence was between 7.2% and 8.8% (or more).

State laws require registration of all live births within the United States from all 50 states and Washington, DC. Electronic files were made available to the CDC's National Center for Health Statistics through the National Vital Statistics Cooperative Program. Only data on births occurring within the United States to U.S. residents were present. Births that occurred in unrevised states were represented by "blanks" which should be treated as "unknowns," which represented 0.3% of births for the 2014 reporting period (Martin et al., 2015).

No additional permissions were needed to access, process, and analyze data because 2014 birth certificate data is considered public use data. This data was available for download from the CDC's National Center for Health Statistics. The Public Health Service Act restricts data use for health statistics and analytical purposes. This act also states that data could not be used to try to determine the identity of participants (CDC, 2015).

Instrumentation and Operationalization of Constructs

Responsible for collecting and disseminating the nation's official vital statistics, those running the National Vital Statistics System obtained data on births, marriage, death, divorce, and fetal deaths through contracted state partnerships. The U.S. Standard Certificate of Live Birth (Appendix B), undergoes revisions every 10 to 15 years, with the most recent revision before 2003 occurring in 1989 (CDC, 2016). A panel comprised of state vital registration and statistics executives, researchers, and representatives of data providers or user organizations suggested revisions based on current literature, recommendations, and suggestions that coincided with improving the data collection process. Two worksheets were developed and tested: the mother's worksheet and the facility worksheet. The mother's worksheet is used to collect data on race, education, Hispanic origin, WIC participation, and cigarette smoking. Data collected from the facility worksheet comes from medical records of the mother and infant and included birthweight, last menstrual period, the method of delivery, and risk factors. Other modified birth certificate items were maternal race, educational attainment, cigarette use, and maternal morbidity (National Center for Health Statistics, 2017).

Studies assessing reliability and validity have produced mixed results. A retrospective study included evaluation of the validity of health plan and birth certificate data and positive predictive values from information contained within medical charts (n = 802; Andrade et al., 2013). Information on maternal and newborn characteristics collected included: race/ethnicity, gestational age at birth, birthweight, previous pregnancies, and live births. It was found that there was a considerable agreement between (positive predictive values > 90%), between medical record and birth certificate data for measures associated with birthweight, gestational age, race/ethnicity, and prior obstetrical history (Andrade et al., 2013).

Martin et al. (2013) analyzed data from the 2003 birth certificate revision from two states and compared data quality. Martin et al. compared a random sample of 600 births that occurred from 2010-2011 in a state (State A) to a convenience sample of 450 births in 2009 in another state (State B). The hospital medical record and birth certificate data that were analyzed were PNC, birthweight, and pregnancy risk factors. Results indicated that exact agreement (or sensitivity) was high for birthweight within 500 grams for both states, but low to extremely low for the total number of prenatal visits for both. Martin et al. mentioned issues related to the quality of data differences across states and hospitals as well as the failure of some to fully implement the 2003 revisions. Cohen's kappa was used to measure the percentage of agreement of the number of births with conditions that coincided with medical records and birth certificate data, and sensitivity (or true positive) was used to assess correlations between items on the birth certificate and in medical records. Both states showed 90% agreement for birthweight (exact grams), with the exact agreement being substantial for the month of first PNC visit (76.6% and 79.6%). Agreement was found to be moderate for both states for the day of the first prenatal visit (71.1% and 66.5%). State A also showed substantial agreement for the total number of PNC visits (84.3%), whereas the lowest exact agreement percentages for both states was the total number of prenatal care visits with State A being 47.8% and State B 22.1%. As wide variation occurred in the sensitivity of some variables between hospitals in State A and B; the authors attributed this phenomenon to underreporting and misreporting of birth certificate data for medical and health conditions as well as differences in sampling techniques.

A 2013 study included a longitudinal analysis using Early Childhood Longitudinal Study-Birth Cohort to compare GWG recall by new mothers approximately 10 months postpartum as compared to birth certificate data as found in 5,650 records (Hinkle et al., 2013). Results showed postpartum estimates were approximately two pounds higher (with a standard error of .2 pounds) with 18.2 % of responses being underreported by more than five pounds, 54.7 % fell within five pounds, and 27.2 % being over-reported by five pounds or more. Bias was shown to differ by birth outcome, suggesting a higher propensity for recall bias, as well as noting significant increases in bias among women who had a prepregnancy weight classification as obese, were multiparous, or had inadequate PNC. However, when classified by adequacy based upon 2009 Institute of Medicine GWG recommendations, results showed that 70% of associations between "GWG adequacy and small- and large-birthweight-for-gestational-age did not differ meaningfully by the source of GWG data" (Hinkle et al., 2013). Evidence showed that in the absence of medical records, birth certificate data would be a reliable substitute, and vice versa (Hinkle et al., 2013). Another study included assessment of the validity of birth certificate-derived maternal weight data to evaluate the accuracy of reported prepregnancy BMI and GWG data from 2003-2010 at a teaching hospital in Pennsylvania. Study findings showed that race/ethnicity, GWG, BMI, and preterm births, were reliable.

This instrument contained the necessary independent, dependent, mediating, and moderating variables to carry out a quantitative analysis. Also, it is widely used to analyze and track maternal and infant health indicators of LBW, maternal morbidity, and PNC use (Curtin, Gregory, Korst, & Uddin, 2015; Loftus, Stewart, Hensley, Enquobahrie, 2015; Martin et al., 2015). The accuracy of reported birthweights is consistently confirmed in the literature and is sufficient for research and programmatic purposes (Gayle, Yip, Frank, Nieburg, & Binkin, 1988; Reichman & Hade, 2001; O'Keeffe, Kearney, & Greene, 2013). However, analyses focusing on high-risk women require additional considerations regarding sensitivity. No additional permissions were needed to access, process, and analyze data because 2014 birth certificate data is considered public use data.

Operationalization of Variables

All variables in the 2014 natality public use file were recorded in a fixed format, with a coding scheme of either numeric, alphabetic, or blank. Each variable was in a specific numerical position based on defined categories. Categories included: general, prenatal care, child, mother, pregnancy history, father, other items, and medical and health data. The position of each variable signifies its location in the data table. Study variables and their positions are in Appendix A, 2014 Natality Data Dictionary. Operationalization of variables was as follows: The primary study variables of this study were PNC (independent exposure variable), GWG (independent variable), and infant birthweight (dependent outcome variables). PNC (PRECARE) was measured on a nominal scale as it was merely a categorical representation of prenatal care utilization.

PNC took on a bivariate response of yes or no describing whether respondents accessed PNC services or not. In this form, PNC made no mention of frequency of visits and simply represented a quantification of the sample that utilized PNC services or not. Regarding mediation, PNC was quantified based on the number of visits during respective trimesters to determine if mediation of the GWG/LBW relationship was supported based on the frequency or timing of visits. PNC in positions 224-225 defined as the month PNC began, took on the following values: (a) 00 represented no PNC; and (b) 01-10, represented the month PNC began. The prenatal care variable was recoded into the (PRECARE5) variable in position 27 to represent trimesters and took on the following values:

1. First trimester
2. Second trimester
3. Third trimester
4. No PNC.

This variable was measured on an interval scale as the order was essential and equal intervals existed between the measurements in representing the trimester of pregnancy. PNC visits (PREVIS-REC) in positions 242-243 were measured on an interval scale and was represented by the following values:

01. No visits
02. 1-2 visits
03. 3-4 visits
04. 5-6 visits

05. 7-8 visits

06. 9-10 visits

07. 11-12 visits

08. 13-14 visits

09. 15-16 visits

10. 17-18 visits

11. 19 or more visits.

PNC, as measured in this study, was represented both categorically in that the month prenatal care began was analyzed, and as a discrete variable, as the quantitative (numerical) values in some of the recoded variables took on a finite number of values. Maternal race was measured on a nominal (categorical) scale and based on self-identification by participants. Maternal race was bridged, and those that identified as a single race, and those that identified as more than one race were bridged together. Race (MBRACE) in position 110 took on the following values:

1. White

2. Black

3. American Indian or Alaskan Native

4. Asian or Pacific Islander

To coincide with the study purpose the variable weight gain (WTGAIN) in positions 304-305 was measured as a continuous interval variable as the responses were coded as follows: 00-97, weight gain in pounds; and 98, 98 pounds and over. Birthweight (BWTR12) was analyzed to address the issue of LBW. LBW was analyzed as a bivariate as the value responses were either yes or no. The “yes” category of LBW represented live infants born weighing less 2499 grams or less and the “no” category was indicative of live infants born weighing 2500 grams or more. A continuous variable in positions 509-510, BWTR12 was measured on an interval scale and had the following values:

01. 0227 - 0499 grams

02. 0500 – 0999 grams

03. 1000 - 1499 grams

04. 1500 – 1999 grams

05. 2000 – 2499 grams

06. 2500 – 2999 grams

07. 3000 – 3499 grams

08. 3500 – 3999 grams

09. 4000 – 4499 grams

10. 4500 – 4999 grams

11. 5000 – 8165 grams.

Imputation was used to treat missing values. Nominal and ordinal values that were missing were imputed by randomly sampling the observed categories. Scale variables were imputed using predicted values from the regression (the mean), followed by addition of a random amount to each imputed value based on the prediction error (Gelman & Hill, 2006). Unknown values were excluded from the study.

Operationalization of Potential Confounding Variables

Educational attainment is another potential confounder of the association between PNC, GWG, and LBW. Educational attainment (MEDUC) was a nominal categorical variable that took on the following values and definitions:

1. eight grade or less
2. ninth through twelfth grade with no diploma
3. high school graduate or GED completed
4. some college credit, but not a degree
5. Associate degree (AA, AS)
6. Bachelor's degree (BA, BS AB)
7. Master's degree (MA, MS, MEng, MSW, MBA)
8. Doctorate (Ph.D., EdD) or professional degree (MD, DDS, DVM, LLB, JD)

BMI (BMI_R), a nominal variable was calculated based on maternal prepregnancy weight (PWgt_r), a discrete variable. BMI took on the following coding schemes:

1. Underweight < 18.5
2. Normal, 18.5-24.9
3. Overweight, 25.0-29.9
4. Obesity I, 35.0-34.9
5. Obesity II, 35.0-39.9
6. Extreme Obesity III, ≥ 40

Marital status (DMAR) in position 120, was categorical and measured on an ordinal scale as the responses indicated direction, as well as information on the level of agreement of the responses, was as follows:

1. Married
2. Unmarried

Cigarette use by trimester in positions 261-264, was measured on an ordinal scale and took on the following values for each variable:

0. Nonsmoker
1. 1-5
2. 6-10
3. 11-20
4. 21-40
5. 41 or more

The values of this variable allowed for analysis of the relationship between cigarettes used during each trimester and the primary study variables. The maternal risk factor gestational diabetes (RF_GDIAB in position 314) was measured on a nominal scale and had a bivariate response of (a) yes or (b) no.

Data Analysis Plan

Stata version 14.1 statistical software was used to carry out statistical analyses. Collected from all 50 states, the CDC National Center for Health Statistics receives birth data from all vital registration areas electronically through the Vital Statistics Cooperative Program. Inclusion criteria were births that occurred to U.S. residents and within the United States. Exclusion criteria were births that occurred to nonresidents or residents that resided outside of the United States. As some areas delayed implementation of the 2003 Standard Certificate of Live Births, 2014 data included data for both versions of the document. As a result, reporting "flags" were developed to help distinguish records that were not comparable between the 1989 and 2003 versions, as well as identify areas that had collected data of sufficient or insufficient quality (CDC, 2015). Also, 2014 natality data utilized "blanks" to represent items in revised areas that were not common or comparable across revisions, representing 0.3% of births (CDC, 2015). Blanks were treated as unknowns for tabulation purposes. Flags and blanks aided in accurately tallying births with incomplete national data. Computed rates for vital data related the vital events of a group to the population of a similarly defined group (e.g., 2014 births and 2014 LBW infants). This approach aided in avoiding discrepancies from differences in the enumeration methods used to obtain population data versus the registration method used to collect vital statistics data (Schachter, 1962).

Data extracted came from the mothers and facility worksheets. There were differences in data quality and type from each state, and within states as the collection of hospital data differed (CDC, 2015). Data for some entries were missing and did not meet the threshold criteria for inclusion. Electronic files were checked automatically for inconsistencies between data items, individual item code validity, and completeness. An ongoing analysis was also conducted to detect issues in overall quality such as failure to follow coding rules established by National Center for Health Statistics, system and software errors, and inadequate reporting. The National Center for Health Statistics used statistical tests to highlight differences for follow-up. Registration areas were informed if differences were found and asked for a verification of counts or determination of differences, followed by transmittal of corrections to the National Center for Health Statistics. A review of the study research study questions follows. The research questions for the study were:

RQ1: Is there a significant association between gestational weight gain and low birthweight?

H_0: There is no significant association between gestational weight gain and low birthweight.

H_a: There is a significant association between gestational weight gain and low birthweight.

RQ2: Does prenatal care have a mediating role in the relationship between gestational weight gain and low birthweight?

H_0: Prenatal care does not have a mediating role in the relationship between gestational weight gain and low birthweight.

H_a: Prenatal care does have a mediating role in the relationship between gestational weight gain and low birthweight.

RQ3: Does prenatal care have a mediating role in the relationship between gestational weight gain and low birthweight that differs by racial group?

H_0: Prenatal care does not have a mediating role in the relationship between gestational weight gain and low birthweight that differs by racial group.

H_a: Prenatal care does have a mediating role in the relationship between gestational weight gain and low birthweight that differs by racial group.

This quantitative analysis analyzed 2014 birth certificate data (see Appendix B) using a combination of descriptive statistics, correlational analysis, and multivariate analyses. Descriptive statistics were used to summarize the frequency of each variable and determine the incidence of LBW by race. Univariate analysis helped summarize the distribution of the frequency and use of PNC, the range of GWG among the sample, and the range of birthweights of live infants in 2014. Spearman's rank correlation was carried out to determine if there was a statistically significant relationship between GWG and LWB. Binary logistic regression was carried out to determine if there was a statistically significant relationship between GWG and LBW in the presence of confounding variables (e.g., diabetes, cigarette use, maternal age, race, education, and marital status). Baron and Kenny mediation analysis was carried out to determine whether PNC mediated the relationship between GWG and LBW and if mediation differed by race. The motivation-facilitation theory of prenatal care access was used to explain the role of motivators and facilitators in initiating PNC. This study used a level of significance of less than 5% and a confidence interval of 95% in all analyses utilizing Stata version 14.1 software.

RQ1 was addressed using Spearman rank correlation analysis and binary logistic regression. The independent variable GWG and dependent variable LBW both had quantitative responses and were analyzed using Spearman's rank order correlation coefficient, denoted *r*, with a range between -1 and +1 to depict the direction and strength of the relationship. The observed correlation was analyzed to determine statistical significance utilizing binary logistic regression analysis. This statistical analysis assessed the relationship between a single continuous independent variable (GWG), and the binary dependent variable (LBW) to reflect a non-linear relationship (Sullivan, 2012) in the presence of confounding variables (e.g., diabetes, cigarette use, maternal age, race, education, and marital status).

RQ2 addressed three variables, PNC (independent), GWG (independent), and LBW (dependent), and analyzed whether adding PNC to the logistic regression model discussed in RQ1 mediated the relationship between GWG and LBW. Multivariable methods allowed for analysis of interrelationships among multiple risk factors or exposure variables and a single outcome as stated in the analysis for RQ1 (Sullivan, 2012). Baron and Kenny mediation analysis was used in RQ2 and RQ3 to determine whether PNC (denoted *M*) mediated the relationship between independent variable GWG (denoted *X*) and dependent variable LBW (denoted *Y*) as represented in the single mediator model below (see figure 2).

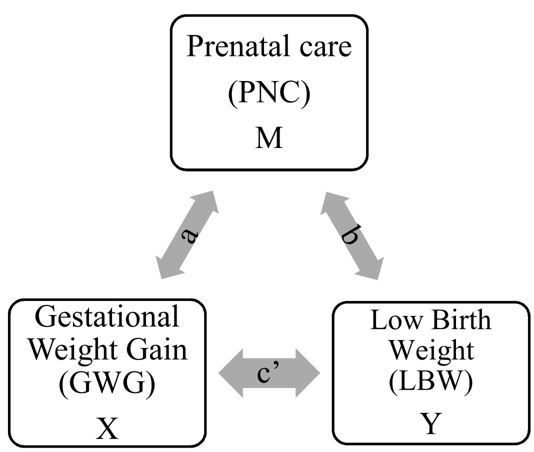

Figure 2. Single mediator model.

Baron and Kenny's mediation analysis (1986), was used to assess and compare the relationship between GWG and LBW before and after adjusting for PNC, the intervening variable. Using a single mediator model coefficient *c'* relates GWG to LBW and was adjusted for the effects of PNC (i.e., the direct effect of GWG on LBW); coefficient *b* relates PNC to LBW and is adjusted for the effects of GWG; and coefficient *a* relates GWG to PNC. The aim of RQ3 was to address if PNC mediated the relationship between GWG and LBW among White, Black, American Indian or Alaskan Native, and Asian or Pacific Islander women. The aim was to also determine if mediation differed by race.

Binary logistic regression and Baron and Kenny mediation analysis applied stepwise procedures using a *p*-value of < .05 from the stratified analysis. Adjustment of models was necessary to account for possible confounding of maternal characteristics and risk factors. This study used a level of significance of less than 5% and a confidence interval of 95% in all analyses utilizing Stata version 14.1 software.

Threats to Validity

Several threats to validity were present in this study. Recall bias, overall and stratum-specific responses, sample sizes for sub-populations, data quality, and generalizability were potential threats. Recall bias and misinterpretation of questions are inherent in recall surveys and could have led to unreliable estimates and prevalence variations when comparing birth certificate data to medical record data. Overall and stratum-specific responses must meet a minimum threshold for minimal nonresponse bias of 65% for inclusion in national samples. Omitting areas that did not meet this threshold could have affected population estimates, and the ability to make statistical inferences

(CDC, 2016). Approximately 3% of data values for maternal education, and BMI were missing/unknown and excluded from analyses which could have led to a reduction in variability, and weakened the covariance and correlation estimates in the data (Sullivan, 2012). There are inherent issues in analyzing birth certificate data. First, the quality of the extracted vital records was dependent on the procedures in place for the hospital that completed the record and could have resulted in underreporting in the prevalence of numerous maternal health indicators (CDC, 2016). This study used the motivation-facilitation theory of prenatal care access as a framework which considered motivating factors that influenced seeking PNC as opposed to barriers. This approach was potentially problematic as there was a risk of misinterpreting data or incorrectly categorizing pregnancy intention (Phillippi & Roman, 2013). Birth certificate data represented a complete count of women that recently gave birth. For this reason, results obtained from statistical analyses and inferences may not have been generalizable as under-represented populations were not over-sampled. The sample consisted of 1104 women from each race.

Potential threats to construct validity were possible as questions may not have been understandable leading to either over- or underreporting of specific constructs. Confounding constructs was another possible threat to validity as the wide geographical range of data collection may not have revealed confounders that were specific to other geographic regions, also affecting the generalizability of results.

Ethical Procedures and Walden IRB

Access to Secondary Data

U.S. 2014 birth certificate natality micro-data is considered public-use and was downloaded from the National Center for Health Statistics website, and no permissions were necessary. The corresponding 2014 user guide for the data set was also available for download. The 2014 birth file was a flat file that required input of a code file to open the file in Stata version 14.1, which was obtained from the National Bureau of Economic Research website.

Treatment of Human Participants

Protection of human subjects was integral to this research. Participant consent is important in protecting study participants, researchers, and organizations. Upon admission to U.S. hospitals for birth, data was collected from expectant mothers as well as from hospital staff for entrance and completion of the U.S. standard birth certificate (CDC, 2017). Confidentiality is important, and the national vital statistics program has taken steps to ensure that participants were not identifiable. For example, publicly accessible micro-data was scrubbed to ensure that any personal identifiers were not present. Also, geographic and date specific details were amended to reflect new confidentiality standards. Before 1989, birth data contained all counties, as well as exact dates; from 1989 to 2004, only geographic identifiers of cities and counties with populations 100,000 or more were present, but no exact dates. Linked birth/death micro-data before 2005, only contained geographic identifiers for counties and cities with populations that were 250,000 or more. In 2005, individual-level vital events data became available at the national level only, with no geographic identifiers, without exact dates, and varied from year to year. Customized birth micro-data files that contain geographic detail for states and counties is available by request. If approved, data will be provided at no cost, on CD or DVD after a review of the request by the National Association for Public Health Statistics and Information Systems (NAPHSIS), the representative of state vital registrars. Some states have regulations or policies, and laws that restrict the release of some information and requests for data could not contravene any state limitation. Upon approval, a data user agreement is issued that govern the use of data by researchers, and renewal and approval processes (CDC, 2017).

Study data will remain on my personal, password-protected laptop. During the original collection of data, study participants were made aware that linking their data with other sources could occur. Walden University's IRB approved this study.

Summary

This section provided an overview of the quantitative analysis utilized for this study and the rationale for why this method was appropriate. Also included was an overview of the research methodology to include the population and sampling techniques. Operationalization of variables and constructs, internal and external validity, an overview of data collection and analysis, and a discussion of ethical procedures were reviewed. A presentation of study results and findings will follow.

Section 3: Presentation of the Results and Findings

Introduction

In this section, I present the data collection, results, and a summary of findings. The purpose of this study was to carry out a quantitative analysis to assess the mediating role of PNC in the relationship between GWG and LBW and whether there were significant differences by racial group. I wanted to determine whether the benefits of PNC posited in the literature (Greenberg, 1983; Krans & Davis, 2014; Lathrop, 2013) extended equally to women and infants of all races while accounting for possible confounding variables. Binary logistic regression only helps determine whether an association exists, whereas Baron and Kenny mediation analysis helps determine if data supports mediation by carrying out a series of three regressions. For data to support mediation four criteria must be met. First, GWG must be related to LBW. Second, GWG must be related to PNC. Next, PNC must be related to LBW while in the presence of the GWG. Lastly, there should not be a significant association between GWG and LBW in the presence of PNC. Research questions and hypotheses that align with the study purpose are as follows:

RQ1: Is there a significant association between gestational weight gain and low birthweight?

H_0: There is no significant association between gestational weight gain and low birthweight.

H_a: There is a significant association between gestational weight gain and low birthweight.

RQ2: Does prenatal care have a mediating role in the relationship between gestational weight gain and low birthweight?

H_0: Prenatal care does not have a mediating role in the relationship between gestational weight gain and low birthweight.

H_a: Prenatal care does have a mediating role in the relationship between gestational weight gain and low birthweight.

RQ3: Does prenatal care have a mediating role in the relationship between gestational weight gain and low birthweight that differs by racial group?

H_0: Prenatal care does not have a mediating role in the relationship between gestational weight gain and low birthweight that differs by racial group.

H_a: Prenatal care does have a mediating role in the relationship between gestational weight gain and low birthweight that differs by racial group.

Data Collection of Secondary Data Set

Following identification of the research variables, the location of the dataset took place within a 2-week time frame. All women that were residents of the United States who had recently given birth to a live infant were eligible to be included in the study. Stratum-specific responses met the CDC guidelines for minimal nonresponse bias of 65% in national samples (CDC, 2016). There were no discrepancies in the use of this dataset as presented in Section 2. Population estimates regarding states that barely met the threshold created a risk of not being able to make statistical inferences (CDC, 2016). The sample was made up of all mothers of childbearing age, who were U.S. residents, and had live births. The sample was stratified by race as follows: White (n = 1,104), Black (n =

1,104), American Indian or Alaskan Native (*n* = 1,104), and Asian or Pacific Islander (*n* = 1,104). Of this sample, mothers who gave birth to LBW infants accounted for 9%, while normal weight and macrosomia infants accounted for 91%. Data showed that in 2014, of the 3,988,076 births, 9.5% were LBW (including LBW and very LBW), making the distribution of LBW births in my sample comparable and representative about birthweight to population estimates.

Descriptive Statistics and Univariate Analysis

Summary statistics were calculated for interval and ratio variables. Frequencies and percentages were calculated for nominal variables. The most frequently observed category of PNC was *Yes* (*n* = 4183, 95%). The most frequently observed category of birthweight was *Normal & Macrosomia* (*n* = 4011, 91%). There were 163 unknown values for PNC and three for birthweight that were excluded from analyses. Frequencies and percentages are presented in Table 1.

Table 1

Frequency Table for Nominal Variables

Variable	*n*	%
PNC		
Yes	4183	94.72
No	70	1.59
Unknown	163	3.69
Missing	0	0.00
Birthweight		
VLBW	80	1.81
LBW	324	7.34
Normal & Macrosomia	4009	90.78
Unknown	3	0.07
Missing	0	0.00

Note. Due to rounding errors, percentages may not equal 100%.

Summary statistics. The observations for maternal age had an average of 4.24 (*SD* = 1.24, SE_M = 0.02, Min = 1.00, Max = 9.00). The observations for marital status had an average of 1.47 (*SD* = 0.50, SE_M = 0.01, Min = 1.00, Max = 2.00). The observations for PNC had an average of 6.73 (*SD* = 2.16, SE_M = 0.03, Min = 1.00, Max = 12.00). The observations for GWG had an average of 32.80 (*SD* = 20.89, SE_M = 0.31, Min = 0.00, Max = 99.00). The observations for maternal education had an average of 4.18 (*SD* = 1.81, SE_M = 0.03, Min = 0.24, Max = 11.62). The observations for BMI had an average of 3.12 (*SD* = 1.67, SE_M = 0.03, Min = -1.02, Max = 9.00). There were 119 values each missing for maternal education and BMI, which were corrected using multiple imputation. Skewness and kurtosis were also calculated and are in Table 2. In assessing symmetry, a skewness value greater than or equal to 2, or less than or equal to -2, signified asymmetry about the variable mean. A value greater than or equal to 3 for kurtosis signifies a variable distribution that is different from that of a normal distribution toward the production of outliers (Westfall & Henning, 2013).

Table 2

Summary Statistics for Interval and Ratio Variables

Variable	*M*	*SD*	*n*	SE_M	Skewness	Kurtosis
Age	4.24	1.24	4416	0.02	0.18	-0.46
Marital status	1.47	0.50	4416	0.01	0.12	-1.99
PNC	6.73	2.16	4416	0.03	0.07	0.49
GWG	32.80	20.89	4416	0.31	1.44	2.70
Education	4.18	1.81	4416	0.03	0.50	-0.42
BMI	3.12	1.67	4416	0.03	1.79	3.61

Note. '-' denotes the sample size is too small to calculate statistic.

Results

Spearman's Rank Correlation

I used Spearman's rank correlation, a nonparametric test, to investigate the relationship between GWG and LBW (see Figure 3), and I ranked/ordered both variables. I also used Spearman's rank correlation to measure the degree of association between GWG and LBW. This analysis did not make any assumptions about the distribution of the data and was the appropriate correlation analysis because the variables measured were at least ordinal level (Conover & Iman, 1981). There were two assumptions necessary to obtain valid results using Spearman's correlation. The assumptions required the variables measured be continuous or ordinal and that the relationship is monotonic. Monotonic means that as the values of one variable increase, the values of the other either increases or decreases, though meeting this assumption is flexible. Cohen's standard was used to evaluate the strength of the relationship. Coefficients between .10 and .29 were representative of small effect size; .30 and .49 were indicative of moderate effect size, and above .50 indicated a large effect size (Cohen, 1988). A Spearman correlation requires that the relationship between variable pairs be monotonic, or not change direction (Conover & Iman, 1981). Violation of this assumption can be visualized in a scatterplot when there is an apparent shift from a positive to negative (or the opposite) relationship.

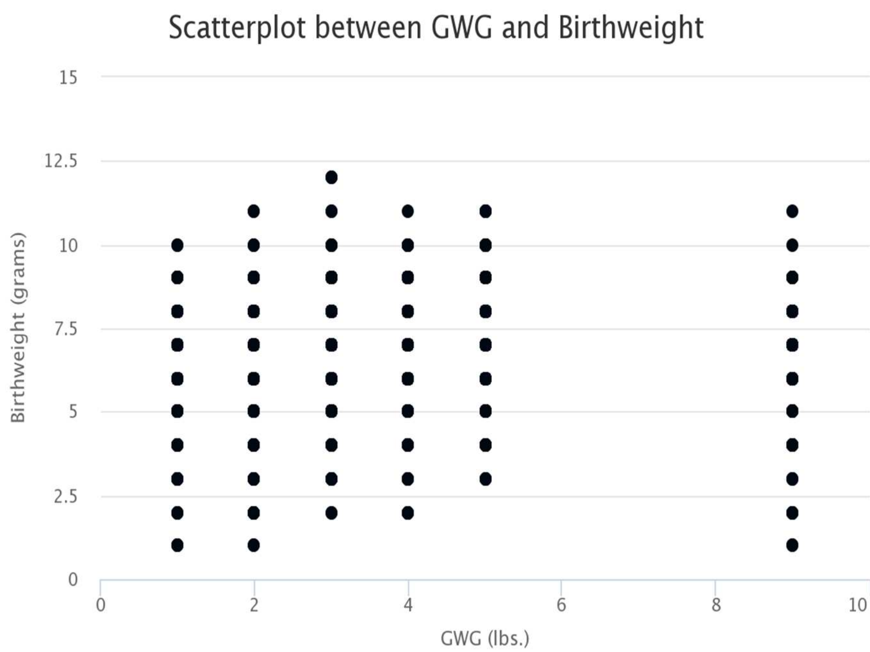

Figure 3. Scatterplot between weight gain and birthweight.

Results. There was a significant positive correlation between GWG and birthweight ($r_s = 0.14$, $p < .001$). The correlation coefficient between weight gain and birthweight was 0.14 indicating a small effect size. This value was an indication that as GWG increases, birthweight increases. Thus, the alternate hypothesis was accepted. respectively.

Spearman's correlation was used to measure the strength of the relationship between GWG and LBW and is denoted r_s, and is constrained by $-1 \leq r_s \leq 1$, with values closer to -1 and 1 indicating a stronger relationship and hence an effect size capable of describing the strength of the relationship. Statistical analysis showed that Spearman's ρ = 0.14, which indicated a small association between the variables. Statistical output stated that Prob > $|t|$ = 0.0000. This value revealed that although the association was small, it was significant because it was less than $p = .05$, indicating rejection of the null hypothesis.

Binary Logistic Regression

Binary logistic regression was carried out to determine whether GWG (independent variable) influenced the odds of observing the *No* category of LBW (dependent binary variable) in the presence of maternal age (IV_1), Black race (IV_2), American Indian or Alaskan Native (IV_3), Asian or Pacific Islander (IV_4), marital status (IV_5), GWG (IV_6), education (IV_7), BMI (IV_8), cigarettes use (IV_9), and gestational diabetes (IV_{10}). The regression equation is as follows:

$$\text{Model 1: DV} = \text{Intercept} + IV_1ß + IV_2ß + IV_3ß + IV_4ß + IV_5ß + IV_6ß + IV_7ß + IV_8ß + IV_9ß + IV_{10}ß \; (R^2 = 0.02)$$

$$\text{LBW} = -2.86 + 0.11 + 0.56 + -0.14 + 0.11 + 0.15 + -0.06 + -0.04 + 0.00 + 0.52 + -0.08$$

Within the equation, DV is the dependent variable, IV is the independent variable, *ß* represents the Beta coefficient, and R^2 is the R-Squared statistic.

The model was fitted by standard maximum likelihood p-values by the Wald Statistic, and the Model Fit Statistics were as follows: $\chi 2 = 50.285$ on 12 df, $p < .001$, $p =$ 4413, and McFadden $R^2 = 0.009$. Binary logistic regression was most appropriate as there were more than one nominal and ordinal variables thought to be mediators of the nominal level dichotomous dependent variable, LBW. The reference category for LBW was *No*. The overall model was significant.

Assumptions. The relationship between multicollinearity and Variance Inflation

Factors (VIFs) is pertinent as VIFs aided in the detection of multicollinearity between possible confounders (Menard, 2010). High VIFs signify amplified effects of multicollinearity in the model. VIFs that are more than five can be problematic in that multicollinearity increases the standard error and can lead to independent variables being found to be insignificant when they are in fact significant. VIF values of 10 should be considered the maximum upper limit (Menard, 2010). Table 3 includes the VIF for each variable in the model.

Table 3

Variance Inflation Factors Based on Variable

Variable	VIF
Age	1.32
Race	1.38
Marital status	1.52
GWG	1.08
Education	1.35
BMI	1.11
Cigarette use	1.13
Gestational diabetes	1.04

Results. The overall model was significant, $\chi^2(12) = 50.29$, $p < .001$, suggesting that maternal age, race, marital status, education, cigarette use, BMI, GWG, and gestational diabetes had a significant effect on the odds of observing the Yes category of LBW. McFadden's R-squared was calculated to examine the model fit, where values greater than .2 are indicative of models with excellent fit (Louviere, Hensher, & Swait, 2000). The McFadden R-squared value calculated for this model was 0.02. The regression coefficient for age was significant, $B = 0.11$, OR = 1.12, $p = .017$, indicating that for a one unit increase in age, the odds of observing the Yes category of LBW would increase by approximately 12%. The regression coefficient for Black race was significant, $B = 0.56$, OR = 1.75, $p < .001$, indicating that for a one unit increase in Black race, the odds of observing the Yes category of LBW would in increase by approximately 75%. The regression coefficient for American Indian or Alaskan Native race was not significant, $B = -0.14$, OR = 0.87, $p = .395$, indicating that American Indian or Alaskan Native race, did not have a significant effect on the odds of observing the Yes category of LBW. The regression coefficient for Asian or Pacific Islander was not significant, $B = 0.11$, OR = 1.12, $p = .486$, indicating that Asian or Pacific Islander race, did not have a significant effect on the odds of observing the Yes category of LBW. The regression coefficient for marital status was not significant, $B = 0.15$, OR = 1.16, $p = .249$, indicating that marital status, did not have a significant effect on the odds of observing the Yes category of LBW. The regression coefficient for GWG was not significant, $B = -0.06$, OR = 0.94, $p = .055$, indicating that GWG, did not have a significant effect on the odds of observing the Yes category of LBW. The regression coefficient for maternal education was not significant, $B = -0.04$, OR = 0.96, $p = .278$, indicating that maternal education, did not have a significant effect on the odds of observing the Yes category of LBW. The regression coefficient for BMI was not significant, $B = 0.00$, OR = 1.00, $p = .971$, indicating that BMI, did not have a significant effect on the odds of observing the Yes category of LBW. The regression coefficient for the Yes category of cigarette use was significant, $B = 0.52$, OR = 1.68, $p = .003$, indicating that for a one unit increase in cigarette use, the odds of observing the Yes category of LBW would increase by approximately 68%. The regression coefficient for the Yes category of gestational diabetes was not significant, *B* = -0.08, OR = 0.93, *p* = .729, indicating that the Yes category of gestational diabetes, did not have a significant effect on the odds of observing the Yes category of LBW. Table 4 summarizes the results of the regression model.

Table 4

Logistic Regression Model Results Based on Variable

Variable	*B*	*SE*	χ^2	*p*	*OR*
(Intercept)	-2.86	0.38	57.89	< .001	
Age	0.11	0.05	5.71	.017	1.12
Race Black	0.56	0.15	14.04	< .001	1.75
Race American Indian or Alaskan Native	-0.14	0.17	0.72	.395	0.87
Race Asian or Pacific Islander	0.11	0.16	0.48	.486	1.12
Marital status	0.15	0.13	1.33	.249	1.16
GWG	-0.06	0.03	3.67	.055	0.94
Education	-0.04	0.03	1.18	.278	0.96
BMI	0.00	0.03	0.00	.971	1.00
Cigarette use	0.52	0.17	9.13	.003	1.68
Gestational diabetes	-0.08	0.22	0.12	.729	0.93

Note. $\chi^2(12) = 50.29$, $p < .001$, McFadden $R^2 = 0.02$.

Baron and Kenny Mediation

Introduction. Baron and Kenny mediation analysis was carried out to determine if PNC mediated the relationship between GWG and birthweight. A series of three regressions were conducted to determine if the data supported mediation. For Step 1, GWG was added to the null model with birthweight. PNC visits were added into the model and analyzed for association with GWG at Step 2. Analysis of GWG, PNC, and LBW occurred in steps 3 and 4. To support mediation, GWG must be related to LBW, GWG must be related to PNC, PNC related to LBW in the presence of GWG, and there should not be a significant association between GWG and LBW in the presence of PNC (Baron & Kenny, 1986). In this analysis, the independent variable was GWG (Y), the mediator was PNC (M), the dependent variable was birthweight (X), and b was the effect. The regression models were as follows:

Step 1:

$$Y=b_0+b_1X+e$$

Birthweight ~ GWG (R^2 = 0.006, $p < .001$)

Step 2:

$$M=b_0+b_2X+e$$

PNC ~ GWG (R^2 = 0.034, $p < .001$)

Steps 3 and 4: $Y=b_0+b_4X+b_3M+e$

Birthweight ~ GWG + PNC (R^2 = 0.011, $p < .001$)

Results. The regression step of birthweight on GWG was significant, $F(2, 4414) = 27.83$, $p < .001$. The results showed that GWG was significantly associated with birthweight, B =0.06, indicating that the first criterion for mediation was satisfied. Second, the regression step associating GWG with PNC was carried out. The regression of PNC on GWG was significant, $F(2, 4414) = 154.24$, $p < .001$. The results showed that GWG was significantly associated with PNC, B = 1.98, indicating that the second criterion for mediation was satisfied. Next, the regression step associating GWG, PNC, and birthweight was carried out. The regression of birthweight on GWG and PNC were significant, $F(3, 4413) = 23.51$, $p < .001$ suggesting that GWG and PNC accounted for a significant amount of variance in birthweight. The results showed that PNC was significantly associated with birthweight when GWG was included in the model, *B* = -0.00, indicating that the third criterion for mediation was satisfied. The results showed that GWG was significantly associated with birthweight when PNC was included in the model, *B* = 0.07, indicating that the fourth criterion for mediation was not satisfied. Items 1, 2, and 3 were met, while the fourth criterion was not. Therefore, data supported partial mediation. Table 5 presents results of mediation analysis.

Table 5

Regression Results with PNC Mediating the Relationship Between Birthweight and GWG Mediation Results

Dependent	Independent	*B*	*SE*	*t*	*p*
Regression 1:					
Birthweight	GWG	0.06	0.01	5.27	< .001
Regression 2:					
PNC	GWG	1.98	0.16	12.42	< .001
Regression 3:					
Birthweight	GWG	0.07	0.01	6.00	< .001
	PNC	-0.00	0.00	-4.37	< .001

RQ3 aimed to determine whether PNC had a mediating role in the relationship between GWG and LBW that differed by racial group. As the null hypothesis for RQ2 was rejected, focus shifted to determining if the same held true for RQ3.

Baron and Kenny Mediation by Race (RQ3)

For Step 1, GWG was entered into the null model with birthweight. PNC visits were added into the model and analyzed for association with GWG at Step 2. In Steps 3 and 4 GWG, PNC, and LBW were analyzed. In this analysis, the independent variable was GWG (Y), the mediator was PNC (M), the dependent variable was birthweight (X), and b was the effect.

White. First, the regression associating GWG and birthweight was carried out. The regression of birthweight on GWG was not significant, $F(2, 1102) = 2.43$, $p = .119$. The results showed that GWG was not significantly associated with birthweight, $B = 1.52$, indicating that the first criterion for mediation was not satisfied. Second, the regression associating GWG with PNC was carried out. The regression of PNC on GWG was significant, $F(2, 1102) = 28.58$, $p < .001$. The results showed that GWG was significantly associated with PNC, $B = 0.13$, indicating that the second criterion for mediation was satisfied. Next, the regression associating GWG and PNC with birthweight was carried out. The regression of birthweight on GWG and PNC was not significant, $F(3, 1101) = 1.31$, $p = .269$ suggesting that GWG and PNC did not account for a significant amount of variance in birthweight. Results showed that PNC was not significantly associated with birthweight when GWG was included in the model, B = -.0.56 indicating that the third criterion for mediation was not satisfied. The results showed that GWG was not significantly associated with birthweight when PNC was included in the model, $B = 1.59$, indicating that the fourth criterion for mediation was satisfied. Since item 1 and item 3 were not met, data did not support mediation. Table 6 presents results of mediation analysis by White race. The regression equation is as follows:

Step 1:

$$Y=b_0+b_1X+e$$

Birthweight ~ GWG (R^2 = 0.002, p = .119)

Step 2:

$$M=b_0+b_2X+e$$

PNC ~ GWG (R^2 = 0.025, p < .001)

Steps 3 and 4: $Y=b_0+b_4X+b_3M+e$

Birthweight ~ GWG + PNC (R^2 = 0.002, p = .269)

Table 6

Regression Results with PNC Mediating the Relationship Between Birthweight and GWG for White race

Dependent	Independent	*B*	*SE*	*t*	*p*
Regression 1:					
Birthweight	GWG	1.52	0.98	1.56	.119
Regression 2:					
PNC	GWG	0.13	0.02	5.35	< .001
Regression 3:					
Birthweight	GWG	1.59	0.99	1.61	.108
	PNC	-0.56	1.25	-0.45	.654

Black. First, the regression model associating GWG and birthweight was carried out. The regression of birthweight on GWG was significant, $F(2, 1102) = 17.02$, $p < .001$. Results showed that GWG was significantly associated with birthweight, $B = 3.57$, indicating that the first criterion for mediation was satisfied. Second, the regression with GWG predicting PNC was carried out. The regression of PNC on GWG was significant, $F(2, 1102) = 53.02$, $p < .001$. The results showed that GWG was significantly associated with PNC, $B = 0.21$, indicating that the second criterion for mediation was satisfied.

Next, the regression of GWG and PNC on birthweight was carried out. The regression of birthweight on GWG and PNC was significant, $F(3, 1101) = 9.58$, $p < .001$ which suggested GWG and PNC accounted for a significant amount of variance in birthweight. The results showed that PNC was not significantly associated with birthweight when GWG was included in the model, $B = -1.33$, indicating that the third criterion for mediation was not satisfied. The results showed that GWG was significantly associated with birthweight when PNC was included in the model, $B = 3.85$, indicating that the fourth criterion for mediation was not satisfied. Since items 3 and 4 did not meet criteria, mediation was not supported. Table 7 presents results of mediation analysis by Black race. The regression equation is as follows:

Step 1:

$$Y=b_0+b_1X+e$$

Birth weight ~ GWG ($R^2 = 0.015$, $p < .001$)

Step 2:

$$M=b_0+b_2X+e$$

PNC ~ GWG ($R^2 = 0.046$, $p < .001$)

Steps 3 and 4: $Y=b_0+b_4X+b_3M+e$

Birth weight ~ GWG + PNC ($R^2 = 0.017$, $p < .001$)

Table 7

Regression Results with PNC Mediating the Relationship between Birthweight and GWG for Black race

Dependent	Independent	*B*	*SE*	*t*	*P*
Regression 1:					

Birthweight	GWG	3.57	0.87	4.13	< .001
Regression 2:					
PNC	GWG	0.21	0.03	7.28	< .001
Regression 3:					
Birthweight	GWG	3.85	0.89	4.34	< .001
	PNC	-1.33	0.92	-1.46	.145

American Indian or Alaskan Native. The regression with GWG and birthweight was carried out. The regression of birthweight on GWG was significant, $F(2, 1102) = 4.72$, $p = .030$. The results showed that GWG was significantly associated with birthweight, $B = 1.93$, indicating that the first criterion for mediation was satisfied. Second, the regression with GWG and PNC was carried out. The regression of PNC on GWG was not significant, $F(2, 1102) = 40.54$, $p < .001$. The results showed that GWG was significantly associated with PNC, $B = 0.14$, indicating that the second criterion for mediation was satisfied. Next, the regression with GWG, PNC, and birthweight was carried out. The regression of birthweight on GWG and PNC was significant, $F(3, 1101) = 11.91$, $p < .001$ suggesting that GWG and PNC accounted for a significant amount of variance in birthweight. Further examination showed that PNC was significantly associated with birthweight when GWG was included in the model, $B = -5.31$, indicating that the third criterion for mediation was satisfied. The results showed that GWG was significantly associated with birthweight when PNC was included in the model, $B = 2.66$, indicating that the fourth criterion for mediation was not satisfied. Since items 1, 2, and 3 were met, but 4 was not, partial mediation was supported. Table 8 presents results of mediation analysis by American Indian or Alaskan Native race. The regression equation is as follows:

Step 1:

$$Y=b_0+b_1X+e$$

Birth weight ~ GWG (R^2 = 0.004, p = .030)

Step 2:

$$M=b_0+b_2X+e$$

PNC ~ GWG (R^2 = 0.035, p < .001)

Steps 3 and 4: $Y=b_0+b_4X+b_3M+e$

Birth weight ~ GWG + PNC (R^2 = 0.021, p < .001)

Table 8

Regression Results with PNC Mediating the Relationship Between Birthweight and GWG for American Indian or Alaskan Native race

Dependent	Independent	*B*	*SE*	*t*	*P*
Regression 1:					
Birth weight	GWG	1.92	0/89	2.17	.030
Regression 2:					
PNC	GWG	0.14	0.02	6.37	< .001
Regression 3:					
Birth weight	GWG	2.66	0.89	2.97	.003
	PNC	-5.31	1.22	-4.36	<.001

Asian or Pacific Islander. First, the regression step with GWG and birthweight was carried out. The regression of birthweight on GWG was significant, $F(2, 1102)$ =

9.02, $p = .003$. The results showed that GWG was significantly associated with birthweight, $B = 2.67$, indicating that the first criterion for mediation was satisfied. Second, the regression with GWG and PNC was carried out. The regression of PNC on GWG was significant, $F(2, 1102) = 35.19$, $p < .001$. The results showed that GWG was significantly associated with PNC, $B = 0.17$, indicating that the second criterion for mediation was satisfied. Next, the regression with GWG and PNC and birthweight was carried out. The regression of birthweight on GWG and PNC were significant, $F(3, 1101) = 7.99$, $p < .001$ suggesting that GWG and PNC accounted for a significant amount of variance in birthweight. Further examination showed that PNC was significantly associated with birthweight when GWG was included in the model, $B = -2.41$, indicating that the third criterion for mediation was satisfied. The results showed that GWG was significantly associated with birthweight when PNC was included in the model, $B = 3.09$, indicating that the fourth criterion for mediation was not satisfied. Since items 1, 2, and 3 were met, while 4 was not met, the data supported partial mediation. Table 9 presents results by Asian or Pacific Islander race. The regression equation is as follows:

Step 1:

$$Y=b_0+b_1X+e$$

Birth weight ~ GWG ($R^2 = 0.008$, $p = .003$)

Step 2:

$$M=b_0+b_2X+e$$

PNC ~ GWG ($R^2 = 0.031$, $p < .001$)

Steps 3 and 4: $Y=b_0+b_4X+b_3M+e$

Birth weight ~ GWG + PNC ($R^2 = 0.014$, $p < .001$)

Table 9

Regression Results with PNC Mediating the Relationship Between Birthweight and GWG for Asian or Pacific Islander race

Dependent	Independent	*B*	*SE*	*T*	*P*
Regression 1:					
Birth weight	GWG	2.67	0.89	3.00	.003
Regression 2:					
PNC	GWG	0.17	0.03	5.93	< .001
Regression 3:					
Birth weight	GWG	3.09	0.90	3.43	< .001
	PNC	-2.41	0.92	-2.63	.009

Summary

The research questions aimed to determine if GWG was significantly associated with LBW, if PNC mediated this relationship, and if there were differences by race in the presence of maternal characteristics and risk factors. Spearman's rank correlation showed there was a significant association between GWG and birthweight. Binary logistic regression revealed that there was a significant association between GWG and LBW in the presence of covariates. The relationship between GWG and LBW was found to be significant. Results also revealed that the overall model was significant, suggesting that maternal age, race, marital status, education, cigarette use, BMI, GWG, and gestational diabetes had a significant effect on the odds of observing the Yes category of LBW. Baron and Kenny mediation analysis showed that PNC partially mediated the relationship between GWG and LBW in American Indian or Alaskan and Native Asian or Pacific Islander races. Section 4 entails an interpretation of the findings, limitations of the study, and recommendations for future research. Lastly, section 4 concludes with a discussion of study implications as applicable to professional practice and social change, followed by the conclusion.

Section 4: Application to Professional Practice and Implications for Social Change

Introduction

The purpose of this study was to conduct a quantitative analysis to assess the mediating role of PNC in the relationship between GWG and LBW and whether there were significant differences by racial group. I wanted to determine whether the benefits of PNC posited in the literature (Greenberg, 1983; Krans & Davis, 2014; Lathrop, 2013) extended equally to women and infants of all races while accounting for possible confounding variables. Key findings of the study were that GWG was significantly associated with LBW. Furthermore, results showed that PNC was a partial mediator of the relationship between GWG and LBW in American Indian or Alaskan and Native Asian or Pacific Islander races. Study findings also showed that maternal age, race, marital status, education, cigarette use, BMI, GWG, and gestational diabetes had a significant effect on the odds of observing the *Yes* category of LBW.

Interpretation of the Findings

A review of the current and past literature shows consistent inferences between GWG and infant birthweight with insufficient weight gain being related to the incidence of LBW infants (Alberico et al., 2014; Berger et al., 2015; Li et al., 2013). The findings of this study also confirmed that there was a statistically significant association between GWG and LBW. Researchers have not clearly delineated the efficacy of PNC in the maternal/infant relationship and why it differs by race. For example, PNC only partially mediated the relationship between GWG and LBW in American Indian or Alaskan and Native Asian or Pacific Islander women in this study, but did not support mediation at all in White women, which has been posited in the literature. Literature reviewed also showed that excess GWG is a protective factor, and though first trimester PNC initiation declined across all races, Black race was still associated with higher rates of LBW infants for reasons unknown (Abrams & Selvin, 1995; Davis et al., 2014; Healthy People 2020, 2016). Empirical testing of effectiveness has not been conducted based on my review of the literature, and PNC indices lack standardization to permit efficacious analyses across models. This study also confirmed that age, Black race, and cigarette use are significantly associated with LBW. For a one-unit increase in age, the odds of observing the *Yes* category of LBW would increase by approximately 12%; for a one-unit increase in Black race, the odds of observing the *Yes* category of LBW would in increase by approximately 75%; and for a one-unit increase in cigarette use, the odds of observing the *Yes* category of LBW would increase by approximately 68%. These factors have also been confirmed in the literature presented in this study. Researchers have shown that maternal ages at the lower and upper limits are risk factors for LBW, whereas PNC initiation and sustainment have afforded some protection from adverse birth outcomes for those who sought care (see Dennis & Mollborn, 2013; see Heaman et al., 2015; see Xaverius et al., 2016). Data from the 2014 period showed that despite public health officials' best efforts to associate teenage pregnancy with higher rates of LBW, teen birth rates declined between 5% and 16% in 43 states and Washington, DC (CDC, 2016).

The motivation-facilitation theory of PNC access differs from other theories in that the focus is on maternal desires to begin and maintain care, and facilitation such as clinical goals to create open access to beneficial, person-centered care (Phillippi &

Roman, 2013). Nationwide efforts and campaigns have served as motivators for public health officials to facilitate dissemination of resources aimed at influencing teenage girls and boys to abstain from sex and which have promoted the use of contraception (The National Campaign, 2017; Stevens, 2015). White race is one factor that has been attributed to increased motivation to initiate PNC (Healthy People 2020, 2016). Graphical representation revealed that in 2014 the Healthy People 2020 objective of having 77.9% of expectant mothers initiate PNC within the first trimester was not met and White women continued to have the highest first-trimester PNC initiation rates (20%), though Black women no longer had the lowest rates of compliance (16.8%; see Figure 4).

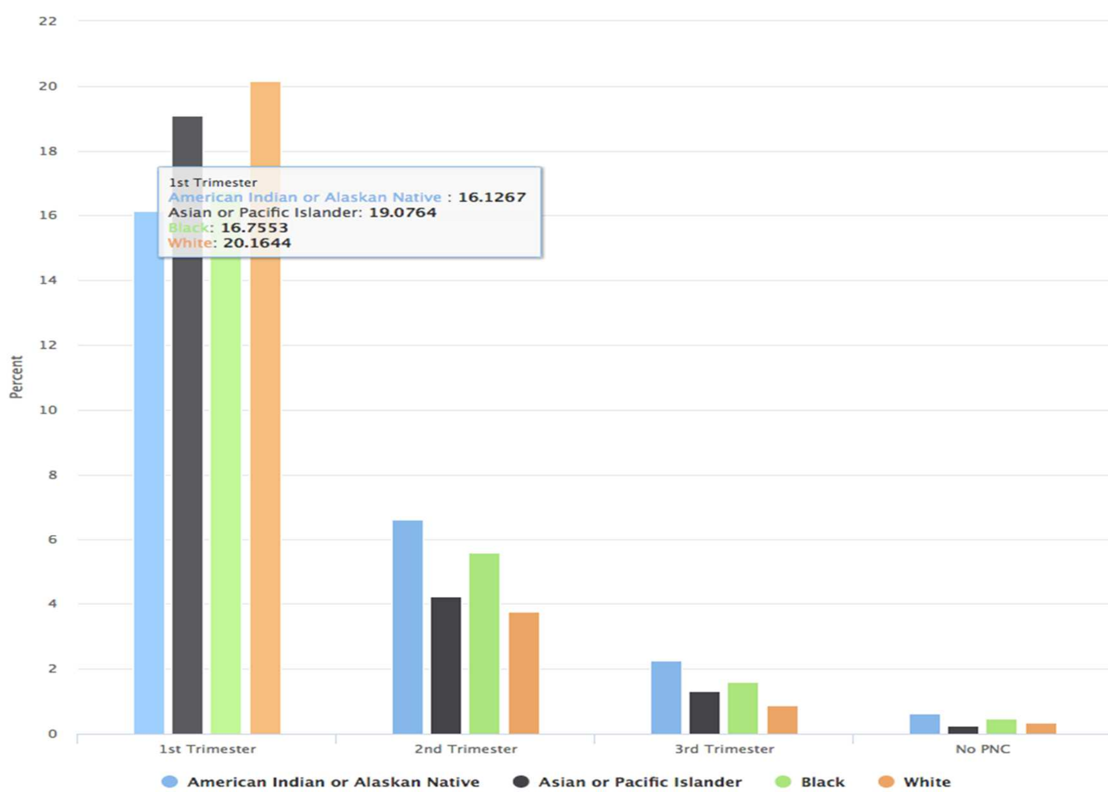

Figure 4. Barplot of PNC access grouped by maternal race.

Smoking is another major risk factor of LBW and cessation efforts are often integrated into PNC services (Windsor et al., 2014). According to the American Pregnancy Association (2017), maternal smoking contributed to 20-30% of infants born with LBW, with 12-30% of pregnant women admitting to smoking while pregnant. Studies have shown that integrating smoking cessation as a part of PNC serves as a positive motivator while highlighting the role of providers in the facilitation of care (Colomar et al., 2015)

Univariate analysis in this study also showed that, of the pregnant women who used PNC services, 89.7% did not smoke while only 8.6% did. In the sample used for this study, the percentage of women who did not use PNC services was small—1.4% of these women did not smoke compared to 0.2% that did, which suggests that other motivators deserve consideration. Likewise, study results showed that the percentage of pregnant women who maintained a normal BMI and accessed PNC services was 45% (see Figure 5).

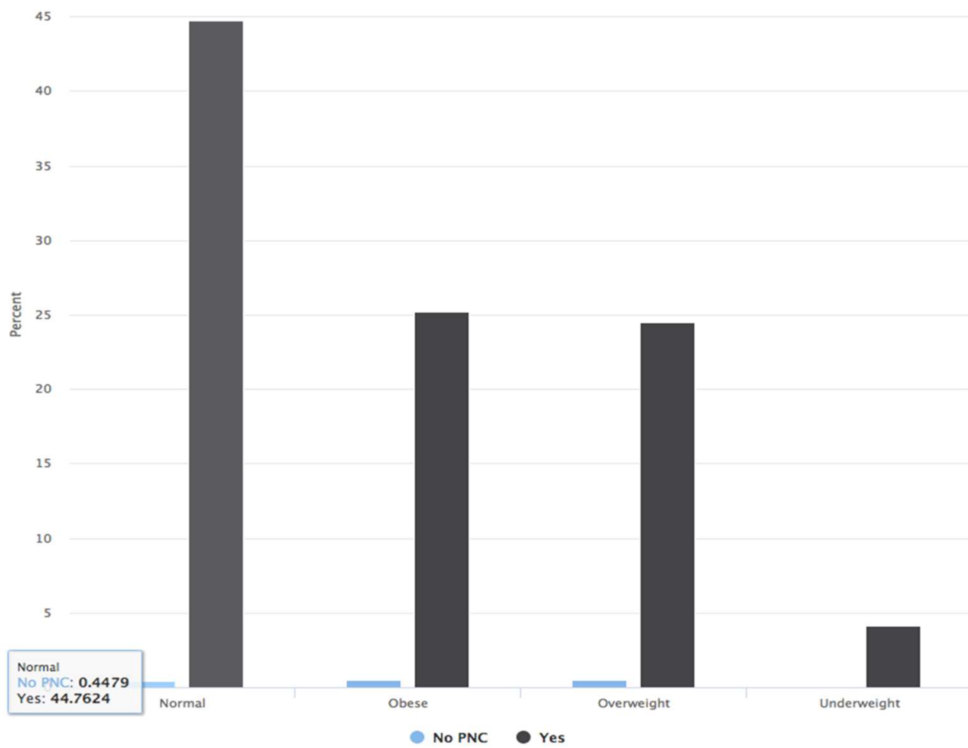

Figure 5. Barplot of PNC access grouped by BMI category.

Limitations of the Study

There are inherent issues with the collection of data from human participants. Lapses in judgment could result in responses that are not factual, potentially shielding relevant variables and relationships that could lead to confounding factors. Time, memory lapses, misunderstanding of questions, and underreporting and/or inaccurate reporting procedures were other potential limitations of this study. Differences in how gestational age is reported by hospitals and states was a study limitation as the scale and metric units used often differ between hospitals (National Center for Health Statistics, 2017). It was not possible for me to ascertain clinical intention or identify state-level data using 2014 public-use micro-data. This restriction potentially prevented the assessment of valuable correlations that may have been pertinent to explaining geographical differences in PNC utilization. Blanks were inserted in areas where responses did not meet the threshold. Entering blanks affected accurate quantification and made variables from different assessment periods incomparable. National data were analyzed which increased the possibility of overlooking adverse maternal and birth outcomes specific to regions and at the state level. Lastly, my use of a stratified random sampling technique to select the study sample could have potentially caused study results not to be generalizable.

Recommendations and Implications for Professional Practice and Social Change

My study results support the need for research focused on sublevel analysis of maternal characteristics that have been linked to higher rates of adverse maternal and infant health outcomes. Recent literature has shown a significant association between maternal race, age, smoking, and LBW (Hamilton et al., 2015; Xaverius et al., 2016). This study also confirmed those findings and showed a significant association between maternal age, Black race, smoking and LBW. In recent literature, Black race has been associated with LBW as Black women are less likely to initiate PNC within the first trimester, are more socioeconomically disadvantaged, and have higher rates of overweight and obesity (Bediako et al., 2015). I recommend that future researchers use a qualitative case-control approach to determine if ongoing efforts to combat teenage pregnancy have a statistically significant association with declining teenage pregnancy rates as compared to a control group, thus negating the effect of age.

GWG was found to be significantly associated with LBW, though PNC was found to be only a partial mediator of this relationship in this study among American Indian or Alaskan Native and Asian or Pacific Islanders.

As the use of PNC indices is inadequate in determining the quality of care (Kotelchuck, 1994), future studies should aim to implement a comprehensive, standardized PNC index that will allow providers to assess better the advantages and shortcomings of PNC. Micro-level analysis to look at cultural, familial, and social influences should also be assessed in future studies to aid in filling in the gaps where race, age, maternal education, and marital statuses have failed to explain the disparities that exist. The motivation-facilitation theory of prenatal care access is relatively new therefore, future studies should also employ a qualitative approach to attaining data on motivators and facilitators of care, focusing on individuals and groups that experience multiple barriers to care. Future studies should also focus on state-level analyses to determine influencing factors that may be prevalent in one area but not others, as the incidence of LBW differs by geographical region (Martinson & Reichman, 2016).

These recommendations for future research may help public health officials understand why specific groups experience adverse birth outcomes as compared to others. Studies on these topics may also equip providers and public health officials with information necessary to increase the effectiveness and deliverance of PNC services, potentially reducing LBW nationally. Lastly, study findings may potentially lead to creation of a standardized PNC index that considers quality of care in addition to quantity.

Social Change

This study may promote social change by informing policies aimed at reducing disparities in adverse maternal and infant health outcomes in the United States by focusing on race-specific motivators. As such, fostering compliance may also ensure that interventions are culturally sensitive and appropriate to bring about the desired changes. Health equity involves ensuring optimal health and the removal of barriers (e.g., personal, social support, attitudinal, and health care system barriers and program and service facets) that are unnecessary, unavoidable, unfair, and unjust towards the advancement of health (Marmot & Allen, 2014). Awareness of study findings may enable practitioners to remove systematic barriers (e.g., institutional practices, hours of operation, patient sensitivity, and cultural competence of staff) and traditional practices that have been prevalent in addressing access, content, and barriers to PNC (Roozbeh, Nahidi, & Hajiyan, 2016).

Application of study findings could also potentially lead to an increase in the uptake of positive behaviors, support systems, and clinical support to expectant mothers. Health equity may be more attainable as individuals increase uptake of positive behaviors and PNC compliance while decreasing negative behaviors (e.g., tobacco and alcohol use, inadequate nutritional intake, and stress) that may aid in minimizing the disparity gap experienced amongst the racial groups. At the individual level, this study may aid in fostering social change by providing culturally and socially sensitive motivators to expectant mothers that are aimed at family involvement and increased social support systems. This approach may aid in minimizing personal and systematic barriers (i.e., personal beliefs, cultural beliefs, provisions for child care, transportation, more extended office hours, and more locations). Increased awareness of the benefits of PNC through community platforms is another potential implication of this study. Policy implementation can reduce barriers to care by increasing sensitivity and specialized training of obstetricians, providers, and clinical staff. Training should ensure providers and staff are culturally competent and abreast of best practices regarding prenatal and delivery care, effective communicators, and knowledgeable of client rights (Ouma et al., 2010; Senarath, Fernando, & Rodrigo, 2007).

Conclusion

Race is a critical factor in adverse maternal and birth outcomes, and specific racial and ethnic groups are at a higher disadvantage (Hamilton, Martin, & Osterman, 2015). Focusing on race has not advanced the field towards implementation of policies and interventions that have effectively diminished the disparities experienced in adverse birth outcomes. Results from this study showed there to be a significant association between Black race and LBW suggesting the need for further research into micro- and macro-level factors to aid in decreasing the disparity gaps experienced. As higher levels of maternal education and marital status have been associated with increased motivation to seek out and sustain PNC (Clements & Bailey, 2015), there exist motivators outside of these commonly cited factors that serve to steer non-Hispanic Black women and racial groups away from risky behaviors (e.g., smoking, alcohol use, and risky sexual practice).

Motivators such as the desire to give birth to a healthy child and other culturally grounded beliefs deserve consideration in future studies. It is in understanding the perceptions and beliefs of those who are most disenfranchised that the field move towards a place of being able to enact social change. Assessing the influence of race on adverse birth outcomes has failed to explain the disparities that exist in PNC utilization. Therefore, there is a need for qualitative research aimed at addressing ethnic groups as these groups have the highest rates of PNC noncompliance, as well as rates of LBW (Bediako et al., 2015). Until the focus is removed from race and focused at the individual and community level, the disparities experienced regarding birth outcomes will remain.

References

Abrams, B., & Selvin, S. (1995). Maternal weight gain pattern and birthweight. *Obstetrics & Gynecology*, *86*(2), 163–169. doi:10.1016/0029-7844(95)00118-b

Alberico, S., Montico, M., Barresi, V., Monasta, L., Businelli, C., Soini, A., . . . Maso, G. (2014). The role of gestational diabetes, prepregnancy body mass index and gestational weight gain on the risk of newborn macrosomia: Results from a prospective multicentre study. *BMC Pregnancy and Childbirth, 14*(1). doi:10.1186/1471-2393-14-23

Alexander, G. R., & Cornely, D. A. (1986). Prenatal care utilization: Its measurement and relationship to pregnancy outcome. *American Journal of Preventive Medicine*, *3*(5), 243–253. doi:10.1016/s0749-3797(18)31241-8

Alexander, G. R., & Korenbrot, C. C. (1995). The role of prenatal care in preventing low birthweight. *The Future of Children, 5*(1), 103. doi:10.2307/1602510

Alexander, G. R., & Kotelchuck, M. (1996). Quantifying the adequacy of prenatal care: A comparison of indices. *Public Health Reports*, *111*(5), 408. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1381783/pdf/pubhealthrep00046-0026.pdf

Alexander, G. R., & Kotelchuck, M. (2001). Assessing the role and effectiveness of prenatal care: History, challenges, and directions for future research. *Public Health Reports*, *116*(4), 306–316. doi:10.1016/s0033-3549(04)50052-3

American College of Obstetricians and Gynecologists. (2013). ACOG Committee opinion no. 548: Weight gain during pregnancy. *Obstetrics and Gynecology*, *121*(1), 210. doi:10.1097/01.aog.0000425668.87506.4c

American Pregnancy Association. (2017, April 12). *Smoking During Pregnancy*. Retrieved from http://americanpregnancy.org/pregnancy-health/smoking-during-pregnancy/

Andrade, S. E., Scott, P. E., Davis, R. L., Li, D. K., Getahun, D., Cheetham, T. C., Cooper, W. O. (2013). Validity of health plan and birth certificate data for pregnancy research. *Pharmacoepidemiology and Drug Safety*, *22*(1), 7–15. doi:10.1002/pds.3319

Avci, S., Col, M., Yavuz, Y., & Yilmaz, E. A. (2016). Prediction by maternal risk factors and prenatal care of neonatal intensive care of neonatal intensive care admission in a university hospital, Turkey, a case control study. *Medical Science and Discovery*, *3*(9), 325–33. doi:10.17546/msd.18762

Baeten J. M., Bukusi E.A., & Lambe, M. (2001). Pregnancy complications and outcomes among overweight and obese nulliparous women. *American Journal of Public Health, 91*(3), 436–440. doi:10.2105/ajph.91.3.436

Ballantyne, J. W. (1901). A plea for a pro-maternity hospital. *British Medical Journal*, *1*(2101), 813–814. doi:10.1136/bmj.1.2101.813

Ballantyne, J. W. (1905). Manual of antenatal pathology and hygiene (Vol. 2). *The American Journal of the Medical Sciences*, *130*(6), 1092-1094. doi:10.1097/00000441-190512000-00014

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations.

Journal of Personality and Social Psychology, 51(6), 1173–1182. doi:10.1037/0022-3514.51.6.1173

Barker, D. J., Winter, P. D., Osmond, C., Margetts, B., & Simmonds, S. J. (1989). Weight in infancy and death from ischemic heart disease. *The Lancet, 2*, 577–580. doi:10.1016/s0140-6736(89)90710-1

Barker, D. J., Osmond, C., Simmonds, S. J., & Wield, G. A. (1993). The relation of small head circumference and thinness at birth to death from cardiovascular disease in adult life. *BMJ, 306*(6875), 422–426. doi:10.1136/bmj.306.6875.422

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173–1182. doi:10.1037//0022-3514.51.6.1173

Bediako, P. T., BeLue, R., & Hillemeier, M. M. (2015). A comparison of birth outcomes among Black, Hispanic, and Black Hispanic Women. *Journal of Racial and Ethnic Health Disparities*, *2*(4), 573–582. doi:10.1007/s40615-015-0110-2

Berger, A. A., Levitan, G., Baxter, J. K., & Lerner-Geva, L. (2015). Gestational weight gain below the 2009 Institute of Medicine guidelines modifies preterm birth in obese pregnant women. *Obstetrics & Gynecology, 125*, 102S. doi:10.1097/aog.0000000000000818

Black, M. H., Sacks, D. A., Xiang, A. H., & Lawrence, J. M. (2012). The relative contribution of prepregnancy overweight and obesity, gestational weight gain, and IADPSG-defined gestational diabetes mellitus to fetal overgrowth. *Diabetes Care,* *36(1)*, 56–62. doi:10.2337/dc12-0741

Blehar, M. C., Spong, C., Grady, C., Goldkind, S. F., Sahin, L., & Clayton, J. A. (2013). Enrolling pregnant women: Issues in clinical research. *Women's Health Issues*, *23*(1), e39–e45. doi:10.1016/j.whi.2012.10.003

Blomberg, M. (2011). Maternal and neonatal outcomes among obese women with weight gain below the new Institute of Medicine recommendations. *Obstetrics & Gynecology*, *117*(5), 1065–1070. doi:10.1097/aog.0b013e318214f1d1

Calkins, K., & Devaskar, S. U. (2011). Fetal origins of adult disease. *Current Problems in Pediatric and Adolescent Health Care*, *41*(6), 158–176. doi:10.1016/j.cppeds.2011.01.001

Centers for Disease Control and Prevention. (2015, August 6). *National Vital Statistics System: Linked Birth and Infant Death Data*. Retrieved from http://www.cdc.gov/nchs/linked.htm

Centers for Disease Control and Prevention. (2017, September 27). *National Vital Statistics System: Birth Data*. Retrieved from https://www.cdc.gov/nchs/nvss/births.htm

Clements, A., & Bailey, B. A. (2015, April). Predicting prenatal care utilization: Pregnancy intention, marital status, education, and religiosity. *Annals of Behavioral Medicine, 49*, S207–S207. New York, NY: Springer.

Colomar, M., Tong, V. T., Morello, P., Farr, S. L., Lawsin, C., Dietz, P. M., . . . & Buekens, P. (2015). Barriers and promoters of an evidenced-based smoking cessation counseling during prenatal care in Argentina and Uruguay. *Maternal* *and Child Health Journal*, *19*(7), 1481–1489. doi:10.1007/s10995-014-1652-3

Committee to Study the Prevention of Low Birthweight, Division of Health Promotion and Disease Prevention, & Institute of Medicine. (1985). *Preventing low birthweight*. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK214461/

Conover, W. J., & Iman, R. L. (1981). Rank transformations as a bridge between parametric and nonparametric statistics. *The American Statistician, 35*(3), 124–129. doi:10.1080/00031305.1981.10479327

Creswell, J. W. (2009). *Qualitative, Quantitative, and Mixed Methods Approaches*. Thousand Oaks, California: Sage Publications, Inc.

Curtin, S. C., Gregory, K. D., Korst, L. M., and Uddin, S. F. (2015). Maternal morbidity for vaginal and cesarean deliveries, according to previous cesarean history: New data from the birth certificate, 2013. *National Vital Statistics Reports: From the Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System* 64, no. 4: 1. *MEDLINE with Full Text*, EBSCO*host* (accessed March 17, 2017).

Dai, L. L., Mao, Y. Y., Luo, X. M., & Shen, Y. P. (2014). Prenatal care in combination with maternal educational level has a synergetic effect on the risk of neonatal low birthweight: New findings in a retrospective cohort study in Kunshan city, China. *Plos one*, *9*(11), e113377. doi:10.1371/journal.pone.0113377

Davis, R. R., Hofferth, S. L., & Shenassa, E. D. (2014). Gestational weight gain and risk of infant death in the United States. *American Journal of Public Health*, *104*(S1), S90–S95. doi:10.2105/ajph.2013.301425

De Boo, H. A., & Harding, J. E. (2006). The developmental origins of adult disease (Barker) hypothesis. *Australian and New Zealand Journal of Obstetrics and Gynecology, 46*, 4–14. doi:10.1111/j.1479-828x.2006.00506.x

Dennis, J. A., & Mollborn, S. (2013). Young maternal age and low birthweight risk: An exploration of racial/ethnic disparities in the birth outcomes of mothers in the United States. *The Social Science Journal*, *50*(4), 625–634. doi:10.1016/j.soscij.2013.09.008

Deputy, N. P., Sharma, A. J., & Kim, S. Y. (2015). Gestational weight gain—United States, 2012 and 2013. MMWR. *Morbidity and Mortality Weekly Report, 64*(43), 1215–1220. doi:10.15585/mmwr.mm6443a3

Dillman, D. A. (2000). *Mail and internet surveys: The tailored design method* (Vol. 2). New York: Wiley.

Dominguez, T. P. (2010). Adverse birth outcomes in African American women: The social context of persistent reproductive disadvantage. *Social work in public health*, *26*(1), 3–16. doi:10.1080/10911350902986880

Drake, A. (2004). The intergenerational effects of fetal programming: Non-genomic mechanisms for the inheritance of low birthweight and cardiovascular risk. *Journal of Endocrinology, 180*(1), 1–16. doi:10.1677/joe.0.1800001

Drehmer, M., Duncan, B. B., Kac, G., & Schmidt, M. I. (2013). Association of second and third trimester weight gain in pregnancy with maternal and fetal outcomes. *PLoS One*, *8*(1), e54704. doi:10.1371/journal.pone.0054704

Eisner, V., Brazie, J. V., Pratt, M. W., & Hexter, A. C. (1979). The risk of low birthweight. *American Journal of Public Health*, *69*(9), 887–893. doi:10.2105/ajph.69.9.887

Fox, M., Entringer, S., Buss, C., DeHaene, J., & Wadhwa, P. D. (2015). Intergenerational transmission of the effects of acculturation on health in Hispanic Americans: A fetal programming perspective. *American Journal of Public Health, 105*(S3), S409–S423. doi:10.2105/ajph.2015.302571

Freedman, L. S., & Schatzkin, A. (1992). Sample size for studying intermediate endpoints within intervention trials or observational studies. *American Journal of Epidemiology*, *136*(9), 1148–1159. doi:10.1093/oxfordjournals.aje.a116581

Galjaard, S., Pexsters, A., Devlieger, R., Guelinckx, I., Abdallah, Y., Lewis, C., . . . Luts, J. (2013). The influence of weight gain patterns in pregnancy on fetal growth using cluster analysis in an obese and nonobese population. *Obesity, 21(7)*, 1416–1422. doi:10.1002/oby.20348

Gayle, H. D., Yip, R., Frank, M. J., Nieburg, P., & Binkin, N. J. (1988). Validation of maternally reported birthweights among 46,637 Tennessee WIC program participants. *Public Health Reports*, *103*(2), 143. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1477960/pdf/pubhealthrep00171-0041.pdf

Gelman, A., & Hill, J. (2006). Data analysis using regression and multilevel/hierarchical models. doi:10.1017/cbo9780511790942

Godfrey, K. M., & Barker, D. J. (2001). Fetal programming and adult health. *Public Health Nutrition, 4*(2b). doi:10.1079/phn2001145

Goldfarb, S. S., Smith, W., Epstein, A. E., Burrows, S., & Wingate, M. (2017). Disparities in prenatal care utilization among US versus foreign-born women with chronic conditions. *Journal of Immigrant and Minority Health*, *19*(6), 1263–1270. doi:10.1007/s10903-016-0435-x

Gortmaker, S. L. (1979). The effects of prenatal care upon the health of the newborn. *American Journal of Public Health, 69,* 653–60. doi:10.2105/ajph.69.7.653

Greenberg, R. S. (1983). The impact of prenatal care in different social groups. *American Journal of Obstetrics and Gynecology, 145(7)*, 797–801. doi:10.1016/0002-9378(83)90681-6

Hall, C. S., & Lewin, K. (1936). A dynamic theory of personality. *The American Journal of Psychology, 48*(2), 353. doi:10.2307/1415758

Hamilton, B. E., Martin, J. A., Osterman, M. J., & Curtain, S. C. (2015). Births: Preliminary data for 2014. *National vital statistics reports: From the Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System*, *64*(6), 1–19. Retrieved from https://www.cdc.gov/nchs/data/nvsr/nvsr64/nvsr64_06.pdf

Han, Z., Mulla, S., Beyene, J., Liao, G., & McDonald, S. D. (2011). Maternal underweight and the risk of preterm birth and low birthweight: A systematic review and meta-analyses. *International Journal of Epidemiology, 40*, 65–101. doi:10.1093/ije/dyq195

Harris, J. E. (1982). Prenatal medical care and infant mortality. In *Economic aspects of health* (pp. 13–52). Retrieved from http://www.nber.org/chapters/c6544.pdf

Headen, I., Mujahid, M. S., Cohen, A. K., Rehkopf, D. H., & Abrams, B. (2015). Racial/ethnic disparities in inadequate gestational weight gain differ by prepregnancy weight. *Maternal and Child Health Journal, 19(8)*, 1672–1686. doi:10.1007/s10995-015-1682-5

Healthy People 2020. (2016). Washington, DC: U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion. Retrieved from https://www.healthypeople.gov/2020/topics-objectives/topic/maternal-infant-and-child-health

Heaman, M. I., Sword, W., Elliott, L., Moffatt, M., Helewa, M. E., Morris, H., . . . & Cook, C. (2015a). Barriers and facilitators related to use of prenatal care by inner-city women: Perceptions of health care providers. *BMC pregnancy and childbirth*, *15*(1), 2. doi:10.1186/s12884-015-0431-5

Heaman, M. I., Sword, W., Elliott, L., Moffatt, M., Helewa, M. E., Morris, H., . . . Cook, C. (2015). Perceptions of barriers, facilitators and motivators related to use of prenatal care: A qualitative descriptive study of inner-city women in Winnipeg, Canada. *SAGE Open Medicine*, *3*, 2050312115621314. doi:10.1177/2050312115621314

Hickey, C. (1997). Prenatal weight gain within upper and lower recommended ranges: Effect on birthweight of black and white infants. *Obstetrics & Gynecology, 90*(4), 489–494. doi:10.1016/s0029-7844(97)00301-3

Hillemeier, M. M., Weisman, C. S., Chase, G. A., & Dyer, A. M. (2007). Individual and community predictors of preterm birth and low birthweight along the rural-urban continuum in central Pennsylvania. *The Journal of Rural Health*, *23*(1), 42–48. doi:10.1111/j.1748-0361.2006.00066.x

Hinkle, S. N., Sharma, A. J., Schieve, L. A., Ramakrishnan, U., Swan, D. W., & Stein, A. D. (2013). Reliability of gestational weight gain reported postpartum: A comparison to the birth certificate. *Maternal and child health journal*, *17*(4), 756–765. doi:10.1007/s10995-012-1057-0

Imai, K., Keele, L., & Tingley, D. (2010). A general approach to causal mediation analysis. *Psychological Methods, 15*(4), 309–334. doi:10.1037/a0020761

Jalil, A., Usman, A., & Zakar, R. (2016). Maternal factors determining low birth weight in Punjab: A secondary data analysis. *FWU Journal of Social Sciences, 10*(2), 70-79. Retrieved from http://ezp.waldenulibrary.org/login?url=https://search-proquest-com.ezp.waldenulibrary.org/docview/1859708175?accountid=14872

Jeve, Y. B., Konje, J. C., & Doshani, A. (2015). Placental dysfunction in obese women and antenatal surveillance strategies. *Best Practice & Research Clinical Obstetrics & Gynaecology*, *29*(3), 350–364. doi:10.1016/j.bpobgyn.2014.09.007

Johnson, K. (2012). Addressing women's health needs and improving birth outcomes: Results from a peer-to-peer state Medicaid learning project. *Issue Brief (Common Fund)*, *21*, 1–19. Retrieved from https://pdfs.semanticscholar.org/3682/276ed694681a79f5c83199cda1470ca82e27.pdf

Johnson, J., Clifton, R. G., Roberts, J. M., Myatt, L., Hauth, J. C., Spong, C. Y., . . . Sorokin, Y. (2013). Pregnancy outcomes with weight gain above or below the

2009 Institute of Medicine guidelines. *Obstetrics & Gynecology, 121(5)*, 969–975. doi:10.1097/aog.0b013e31828aea03

Kelishadi, R., & Poursafa, P. (2014). A review on the genetic, environmental, and lifestyle aspects of the early-life origins of cardiovascular disease. *Current Problems in Pediatric and Adolescent Health Care, 44*(3), 54–72. doi:10.1016/j.cppeds.2013.12.005

Koroukian, S. M., & Rimm, A. A. (2002). The "adequacy of prenatal care utilization" (APNCU) index to study low birthweight: Is the index biased? *Journal of Clinical Epidemiology*, *55*(3), 296–305. doi:10.1016/s0895-4356(01)00471-1

Kotelchuck, M. (1994). An evaluation of the Kessner adequacy of prenatal care index and a proposed adequacy of prenatal care utilization index. *American Journal of Public Health*, 84(9), 1414–1420. doi:10.2105/ajph.84.9.1414

Krans, E. & Davis, M. M. (2012). Preventing low birthweight: 25 years, prenatal risk, and the failure to reinvent prenatal care. *American Journal of Obstetrics and Gynecology*, *206*(5), 398–403. doi:10.1016/j.ajog.2011.06.082

Krans, E. & Davis, M. (2014). Strong start for mothers and newborns: Implications for prenatal care delivery. *Current Opinion in Obstetrics & Gynecology*, *26*(6), 511–515. doi.org/10.1097/GCO.0000000000000118

Kristin, M. (2015). Examination of the impact of maternal weight gain on abnormalities of fetal growth in women of varying body mass indices. *Obesity, 1*(3). doi:10.16966/2380-5528.112

Langford, A., Joshu, C., Chang, J. J., Myles, T., & Leet, T. (2011). Does gestational weight gain affect the risk of adverse maternal and infant outcomes in overweight women? *Maternal and Child Health Journal, 15*(7), 860–865. doi:10.1007/s10995-008-0318-4

Lathrop, B. (2013). A systematic review comparing group prenatal care to traditional prenatal care. *Nursing for Women's Health, 17*(2), 118–130. doi:10.1111/1751-486x.12020

Li, N., Liu, E., Guo, J., Pan, L., Li, B., Wang, P., . . . Hu, G. (2013). Maternal prepregnancy body mass index and gestational weight gain on pregnancy outcomes. *PLoS ONE, 8(12)*, e82310. doi:10.1371/journal.pone.0082310

Lindberg, L., Maddow-Zimet, I., Kost, K., & Lincoln, A. (2015). Pregnancy intentions and maternal and child health: An analysis of longitudinal data in Oklahoma. *Maternal and Child Health Journal*, *19*(5), 1087–1096. doi:10.1007/s10995-014-1609-6

Loftus, C. T., Stewart, O. T., Hensley, M. D., Enquobahrie, D. A., & Hawes, S. E. (2015). A longitudinal study of changes in prenatal care utilization between first and second births and low birthweight. *Maternal and Child Health Journal*, *19*(12), 2627–2635. doi:10.1007/s10995-015-1783-1

Lu, M. C., & Halfon, N. (2003). Racial and ethnic disparities in birth outcomes: A life-course perspective. *Maternal and Child Health Journal*, *7*(1), 13–30. doi:10.1023/a:1022537516969

MacDorman, M. F., & Mathews, T. J. (2011). Understanding racial and ethnic disparities in US infant mortality rates. National Center for Health Statistics data brief, No.

74. Hyattsville, MD: National Center for Health Statistics. 2011. http://www.birthbythenumbers.org/wp-content/uploads/2012/11/MacDorman.Race-EthDiffinIMR.9.11.db74-1.pdf

MacDorman, M. F., Mathews, T. J., & Centers for Disease Control and Prevention. (2013). Infant deaths-United States, 2005-2008. *MMWR Surveillance Summary*, *62*(Suppl 3), 171–175. Retrieved from https://www.cdc.gov/mmwr/preview/mmwrhtml/su6203a29.htm

MacDorman, M. F., Matthews, T. J., Mohangoo, A. D., & Zeitlin, J. (2014). International comparisons of infant mortality and related factors: United States and Europe, 2010. *National vital statistics reports: from the Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System*, *63*(5), 1–6. Retrieved from https://stacks.cdc.gov/view/cdc/25388

MacKinnon, D. P., & Tofighi, D. (2012). *Statistical mediation analysis*. Handbook of Psychology, Second Edition. doi:10.1002/9781118133880.hop202025

Mandell, D. J., & Kormondy, M. (2015). Healthy Texas Babies: Data Book. Austin, TX: Division for Family and Community Health Services, Texas Department of State Health Services, 2015. Retrieved from https://www.dshs.texas.gov/healthytexasbabies/.../HTBDatabook_2016-08-31.doc

Marmot, M., & Allen, J. J. (2014). Social determinants of health equity. *American Journal of Public Health, 104*(S4), S517–S519. doi:10.2105/ajph.2014.302200

Martin, J. A., Hamilton, B. E., & Osterman, M. J., Curtin, S. C., Mathews, T. J. (2015). Births: Final data for 2013. *National Vital Statistics Reports*, *64(1)*. Hyattsville, MD: National Center for Health Statistics, 2015. Retrieved from https://stacks.cdc.gov/view/cdc/26749

Martin, J. A., Hamilton, B. E., Osterman, M. J., Driscoll, A. K., & Mathews, T. J. (2017). Births: Final Data for 2015. *National vital statistics reports: From the Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System*, *66*(1), 1. Retrieved from https://www.cdc.gov/nchs/data/nvsr/nvsr66/nvsr66_01.pdf

Martin, A., Krishna, I., Ellis, J., Paccione, R., & Badell, M. (2014). Super obesity in pregnancy: Difficulties in clinical management. *Journal of Perinatology*, *34*(7), 495–502. doi:10.1038/jp.2014.4

Martin, J. A., & Osterman, M. J. (2013). Preterm births—United States, 2006 and 2010. *MMWR Surveillancel Summary*, *62*(suppl 3), 136–138. Retrieved from http://www.inventiveproblemsolving.org/wp-content/uploads/2017/05/CDC-Report-on-Disparities-in-Minority-Health-2013.pdf#page=138

Martinson, M. L., & Reichman, N. E. (2016). Socioeconomic inequalities in low birthweight in the United States, the United Kingdom, Canada, and Australia. *American Journal of Public Health*, *106*(4), 748–754. doi:10.2105/ajph.2015.303007

Matthews, T. J., MacDorman, M.F. (2013). Infant mortality statistics from the 2010 period linked birth/infant death data set. *National vital statistics reports 62*(8); Hyattsville, MD: National Center for Health Statistics, 2013. Retrieved from https://pdfs.semanticscholar.org/cfcd/408f85dcc38fdbf18661ff20619c4ab4f6cc.pd

f

Matthews, T. J., MacDorman, M. F., & Thomas, M. E. (2015). Infant mortality statistics from the 2013 period linked birth/infant death data set. *National vital statistics reports: From the Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System*, *64*(9), 1. Retrieved from https://www.cdc.gov/nchs/data/nvsr/nvsr64/nvsr64_09.pdf

Menard, S. (2010). *Logistic regression: From introductory to advanced concepts and applications*. Thousand Oaks, California: Sage Publications, Inc. doi:10.4135/9781483348964

Muoto, I., Luck, J., Yoon, J., Bernell, S., & Snowden, J. M. (2016). Oregon's coordinated care organizations increased timely prenatal care initiation and decreased disparities. *Health Affairs*, *35*(9), 1625–1632. doi:10.1377/hlthaff.2016.0396

Murphy, S. L., Kochanek, K. D., Xu, J., & Arias, E. (2015). Mortality in the United States, 2014 (National Center for Health Statistics Data Brief 229). Retrieved from https://www.cdc.gov/nchs/data/databriefs/db229.pdf

Murray, J. L., & Bernfield, M. (1988). The differential effect of prenatal care on the incidence of low birthweight among blacks and whites in a prepaid health care plan. *New England Journal of Medicine*, *319*(21), 1385–1391. doi:10.1056/nejm198811243192105

National Center for Health Statistics. (2017, May 3). *Vital Statistics Data Available Online User Guide to the 2014 Natality Public Use File* . Retrieved from Centers for Disease Control and Prevention:

https://www.cdc.gov/nchs/data_access/VitalStatsOnline.htm#Births

National Research Council. (2010). *Weight gain during pregnancy: Reexamining the guidelines*. Washington, DC: National Academies Press.

Nohr, E. A., Vaeth, M., Baker, J. L., Sørensen, T. I., Olsen, J., & Rasmussen, K. M. (2008). Combined associations of prepregnancy body mass index and gestational weight gain with the outcome of pregnancy. *The American Journal of Clinical Nutrition*, *87*(6), 1750–1759. doi:10.1093/ajcn/87.6.1750

Noonan, A. S., Velasco-Mondragon, H. E., & Wagner, F. A. (2016). Improving the health of African Americans in the USA: An overdue opportunity for social justice. *Public Health Reviews, 37*(1). doi:10.1186/s40985-016-0025-4

Novick, G. (2004). Centering pregnancy and the current state of prenatal care. *Journal of Midwifery & Women's Health, 49*(5), 405–411. doi:10.1016/j.jmwh.2004.06.001

O'Keeffe, L. M., Kearney, P. M., & Greene, R. A. (2013). Surveillance during pregnancy: Methods and response rates from a hospital based pilot study of the pregnancy risk assessment monitoring system in Ireland. *BMC Pregnancy and Childbirth*, *13*(1), 180. doi:10.1186/1471-2393-13-180

Ouma, P. O., van Eijk, A. M., Hamel, M. J., Sikuku, E. S., Odhiambo, F. O., Munguti, K. M., . . . & Slutsker, L. (2010). Antenatal and delivery care in rural western Kenya: The effect of training health care workers to provide" focused antenatal care". *Reproductive health*, *7*(1), 1. doi:10.1186/1742-4755-7-1

Partridge, S., Balayla, J., Holcroft, C., & Abenhaim, H. (2012). Inadequate prenatal care utilization and risks of infant mortality and poor birth outcome: A retrospective analysis of 28,729,765 U.S. deliveries over 8 years. *American Journal of Perinatology, 29(10)*, 787–794. doi:10.1055/s-0032-1316439

Phillippi, J. C., & Roman, M. W. (2013). The motivation-facilitation theory of prenatal care access. *Journal of Midwifery & Women's Health*, *58*(5), 509–515. doi.org/10.1111/jmwh.12041

Ray, J. G. (2001). Maternal and neonatal outcomes in pregestational and gestational diabetes mellitus, and the influence of maternal obesity and weight gain: The DEPOSIT study. *QJM, 94(7)*, 347–356. doi:10.1093/qjmed/94.7.347

Reichman, N. E., & Hade, E. M. (2001). Validation of birth certificate data: A study of women in New Jersey's health start program. *Annals of Epidemiology*, *11*(3), 186–193. doi.org/10.1016/s1047-2797(00)00209-x

Roman, L., Raffo, J. E., Zhu, Q., & Meghea, C. I. (2014). A statewide Medicaid enhanced prenatal care program. *JAMA Pediatrics, 168(3)*, 220. doi:10.1001/jamapediatrics.2013.4347

Roopesh, I. (2014, May 11). *Sample size calculation: Cross-sectional studies*. Retrieved from Community Medicine for All Seeking Simple Explanations: https://communitymedicine4asses.wordpress.com/2014/05/11/sample-size-calculation-cross-sectional-studies/

Roozbeh, N., Nahidi, F., & Hajiyan, S. (2016). Barriers related to prenatal care utilization among women. *Saudi Medical Journal*, *37*(12), 1319–1327. http://doi.org/10.15537/smj.2016.12.15505

Savitz, D. A., Stein, C. R., Siega-Riz, A. M., & Herring, A. H. (2011). Gestational weight gain and birth outcome in relation to prepregnancy body mass index and ethnicity. *Annals of Epidemiology, 21*, 78–85. doi:10.1016/j.annepidem.2010.06.009

Schachter, J. (1962). Matched record comparison of birth certificate and census information in the United States, 1950. *Vital statistics—Special reports*, *47*(12).

Schechter, S. (1991). New perspectives on prenatal care: Edited by Irwin R. Merkatz and Joyce E. Thompson. New York: Elsevier Science Publishing Company, 1990. 656 pages. $79.00, hardcover. *Journal of Nurse-Midwifery*, *36*(2), 138–139. doi:10.1016/0091-2182(91)90071-v

Senarath, U., Fernando, D. N., & Rodrigo, I. (2007). Effect of training for care providers on practice of essential newborn care in hospitals in Sri Lanka. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*, *36*(6), 531–541. doi:10.1111/j.1552-6909.2007.00183.x

Sharp, A. N., & Alfirevic, Z. (2014). First trimester screening can predict adverse pregnancy outcomes. *Prenatal Diagnosis*, *34*(7), 660–667. doi:10.1002/pd.4406

Shivayogi, P. (2013). Vulnerable population and methods for their safeguard. *Perspectives in clinical research*, *4*(1), 53. doi:10.4103/2229-3485.106389

Shoff, C., Yang, T. C., & Matthews, S. A. (2012). What has geography got to do with it? Using GWR to explore place-specific associations with prenatal care utilization. *GeoJournal*, *77*(3), 331–341. doi:10.1007/s10708-010-9405-3

Showstack, J. A., Budetti, P. P., & Minkler, D. (1984). Factors associated with birthweight: An exploration of the roles of prenatal care and length of gestation. *American Journal of Public Health, 74*(9), 1003–1008.

doi:10.2105/ajph.74.9.1003

Siega-Riz, A. M., & Laraia, B. (2006). The implications of maternal overweight and obesity on the course of pregnancy and birth outcomes. *Maternal and Child Health Journal*, *10*(1), 153–156. doi:10.1007/s10995-006-0115-x

Sonek, J. D., Kagan, K. O., & Nicolaides, K. H. (2016). Inverted Pyramid of Care. *Clinics in laboratory medicine*, *36*(2), 305–317. doi:10.1016/j.cll.2016.01.009

Stevens, L. M. (2015). Planning parenthood: Health care providers' perspectives on pregnancy intention, readiness, and family planning. *Social science & medicine*, *139*, 44–52. doi.org/10.1016/j.socscimed.2015.06.027

Sullivan, L. M. (2012). *Essentials of biostatistics in public health*. Burlington, MA: Jones & Bartlett Learning.

Taffel, S. 1978. *Prenatal Care, United States 1969–1975*. Vital and Health Statistics. Series 21, No. 33. Rockville, Md.: U.S. National Center for Health Statistics.

Taussig, F. J. (1937). The story of prenatal care: Presidential address. *American Journal of Obstetrics and Gynecology*, *34*(5), 731–739. doi:10.1016/s0002-9378(37)90723-3

Tayebi, T., Zahrani, S. T., & Mohammadpour, R. (2013). Relationship between adequacy of prenatal care utilization index and pregnancy outcomes. *Iranian Journal of Nursing and Midwifery Research*, *18*(5), 360–366. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3877457/

The Centers for Disease Control and Prevention (CDC), National Vital Statistics Reports (NVSR), Vol. 64 No. 12: Births: Final data for 2014 supplemental tables, December 23, 2015. Retrieved from https://www.cdc.gov/nchs/data/nvsr/nvsr64/nvsr64_12.pdf

The National Campaign. (2017). *Sex Education and Effective Programs*. Retrieved from The National Campaign to Prevent Teen and Unplanned Pregnancy: https://thenationalcampaign.org/featured-topics/sex-education-and-effective-programs

Thomas, M., Spielvogel, A., Cohen, F., Fisher-Owens, S., Stotland, N., Wolfe, B., . . . Humway, M. (2014). Maternal differences and birth outcome disparities: Diversity within a high-risk prenatal clinic. *Journal of Racial and Ethnic Health Disparities, 1*(1), 12–20. doi:10.1007/s40615-013-0002-2

United Health Foundation. (2017). *2015 Annual Report*. Retrieved from America's Health Rankings: http://www.americashealthrankings.org/explore/2015-annual-report/measure/birthweight/state/ALL

United States Census Bureau. (2016, December 8). *New Census Data Show Differences Between Urban and Rural Populations*. Retrieved from United States Census Bureau: https://www.census.gov/newsroom/press-releases/2016/cb16-210.html

University of Virginia Library. (2015, August 26). *Understanding Q-Q plots*. Retrieved from University of Virginia Library Research Data Services + Scence: http://data.library.virginia.edu/understanding-q-q-plots/

Van Mieghem, T., Hindryckx, A., & Van Calsteren, K. (2015). Early fetal anatomy screening: Who, what, when and why? *Current Opinion in Obstetrics and Gynecology*, *27*(2), 143–150. doi:10.1097/gco.0000000000000161

VanderWeele, T. J., Lantos, J. D., Siddique, J., & Lauderdale, D. S. (2009). A comparison of four prenatal care indices in birth outcome models: Comparable results for predicting small-for-gestational-age outcome but different results for preterm birth or infant mortality. *Journal of Clinical Epidemiology*, *62*(4), 438–445. doi:10.1016/j.jclinepi.2008.08.001

Visentin, S., Grumolato, F., Nardelli, G. B., Di Camillo, B., Grisan, E., & Cosmi, E. (2014). Early origins of adult disease: Low birthweight and vascular remodeling. *Atherosclerosis, 237(2)*, 391–399. doi:10.1016/j.atherosclerosis.2014.09.027

Windsor, R., Clark, J., Cleary, S., Davis, A., Thorn, S., Abroms, L., & Wedeles, J. (2014). Effectiveness of the smoking cessation and reduction in pregnancy treatment (SCRIPT) dissemination project: A science to prenatal care practice partnership. *Maternal and child health journal*, *18*(1), 180–190. doi:10.1007/s10995-013-1252-7

Witt, W. P., Cheng, E. R., Wisk, L. E., Litzelman, K., Chatterjee, D., Mandell, K., . . . Wakeel, F. (2014). Maternal stressful life events prior to conception and the impact on infant birthweight in the United States. *American Journal of Public Health, 104(S1)*, S81–S89. doi:10.2105/ajph.2013.301544

World Health Organization. (2016). *Maternal and perinatal health*. Retrieved from Maternal, newborn, child and adolescent health: http://www.who.int/maternal_child_adolescent/topics/maternal/maternal_perinatal/en/

Xaverius, P., Alman, C., Holtz, L., & Yarber, L. (2016). Risk factors associated with very low birthweight in a large urban area, stratified by adequacy of prenatal care. *Maternal and Child Health Journal*, *20*(3), 623–629. doi:10.1007/s10995-015-1861-4

Yan, J. (2015). Maternal prepregnancy BMI, gestational weight gain, and infant birthweight: A within-family analysis in the United States. *Economics & Human Biology, 18*, 1–12. doi:10.1016/j.ehb.2015.03.002

Yeo, S., Crandell, J. L., & Jones-Vessey, K. (2016). Adequacy of prenatal care and gestational weight gain. *Journal of Women's Health, 25*(2), 117–123. doi:10.1089/jwh.2015.5468

Yu, Z., Han, S., Zhu, J., Sun, X., Ji, C., & Guo, X. (2013). Prepregnancy body mass index in relation to infant birth weight and offspring overweight/obesity: A systematic review and meta-analysis. *PLoS ONE*, *8*(4), e61627. doi:10.1371/journal.pone.0061627

Zanardo, V., Mazza, A., Parotto, M., Scambia, G., & Straface, G. (2016). Gestational weight gain and fetal growth in underweight women. *Italian Journal of Pediatrics, 42(1)*. doi:10.1186/s13052-016-0284-1

Zhang, S., Cardarelli, K., Shim, R., Ye, J., Booker, K. L., & Rust, G. (2013). Racial disparities in economic and clinical outcomes of pregnancy among Medicaid recipients. *Maternal and Child Health Journal*, *17*(8), 1518–1525. doi:10.1007/s10995-012-1162-0

Appendix A: 2014 Natality Data Dictionary

Position	Length	Field	Description	Values	Definition
79	1	MAGER9	Mother's Age Recode 19	1	Under 15 years
				2	15-19 years
				3	20-24 years
				4	25-29 years
				5	30-34 years
				6	35-39 years
				7	40-44 years
				8	45-49 years
				9	50-54 years
110	1	MBRACE	Bridged Race Mother	1	White
				2	Black
				3	American Indian or Alaskan Native
				4	Asian or Pacific Islander
120	1	DMAR	Marital Status	1	Married
				2	Unmarried
124	1	MEDUC	Mother's Education	1	8th grade or less
				2	9th through 12th grade but no diploma
				3	High school graduate or GED

				4	Some college credit but no degree
				5	Associate degree (AA, AS)
				6	Bachelor's degree (BA, AB, BS)
				7	Master's degree (MA, MS, MEng, MEd, MSW, MBA)
				8	Doctorate (PhD, EdD) or Professional degree (MD, DDS, DVM, LLB, JD)
				9	Unknown
224-225	2	PRECARE	Month Prenatal Care Began	00	No prenatal care
				01-10	Month prenatal care began
				99	Unknown
227	1	PRECARE5	Month Prenatal Care Began Recode	1	1st through 3rd month
				2	4th through 6th month
				3	7th to final month
				4	No prenatal care
				5	Unknown or not stated
242-243	2	PREVIS_REC	Number of prenatal visits recode	01	No visits
				02	1 to 2 visits
				03	3 to 4 visits

				04	5 to 6 visits
				05	7 to 8 visits
				06	9 to 10 visits
				07	11 to 12 visits
				08	13 to 14 visits
				09	15 to 16 visits
				10	17 to 18 visits
				11	19 or more visits
				12	unknown or not stated
262	1	CIG1_R	Cigarettes 1st	0	Nonsmoker
			Trimester Recode	1	1-5
				2	6-10
				3	11-20
				4	21-40
				5	41 or more
				6	unknown or not stated
263	1	CIG2_R	Cigarettes 2nd	0	Nonsmoker
			Trimester Recode	1	1-5
				2	6-10
				3	11-20
				4	21-40
				5	41 or more
				6	unknown or not stated

264	1	CIG3_R	Cigarettes 3rd Trimester Recode	0	Nonsmoker
				1	1-5
				2	6-10
				3	11-20
				4	21-40
				5	41 or more
				6	unknown or not stated
287	1	BMI_R	Body Mass Index Recode	1	Underweight < 18.5
				2	Normal 18.5-24.9
				3	Overweight 25.0-29.9
				4	Obesity I 35.0-34.9
				5	Obesity II 35.0-39.9
				6	Extreme Obesity III≥ 40
				9	Unknown or not stated
292-294	3	PWgt_r	Prepregnancy weight recode	075-375	Weight in pounds
299-301	3	DWgt_R	Delivery weight recode	100-400	Weight in pounds
				999	Unknown or not stated
304-305	2	WTGAIN	Weight Gain	00-97	Weight gain in pounds
				98	98 pounds and over
				99	Unknown or not stated

314	1	RF_GDIAB	Gestational Diabetes	Y N U	Yes No Unknown or unstated
316	1	RF_GHYPE	Gestational Hypertension	Y N U	Yes No Unknown or unstated
511	1	BWTR4	Birth Weight Recode 4	1 2 3 4	0227 - 1499 grams 1500 – 2499 grams 2500 - 8165grams Unknown or not stated

Appendix B: U.S. Standard Certificate of Live Birth 2003 Revision

U.S. STANDARD CERTIFICATE OF LIVE BIRTH

LOCAL FILE NO. BIRTH NUMBER:

CHILD

1. CHILD'S NAME (First, Middle, Last, Suffix)
2. TIME OF BIRTH (24 hr)
3. SEX
4. DATE OF BIRTH (Mo/Day/Yr)
5. FACILITY NAME (If not institution, give street and number)
6. CITY, TOWN, OR LOCATION OF BIRTH
7. COUNTY OF BIRTH

MOTHER

8a. MOTHER'S CURRENT LEGAL NAME (First, Middle, Last, Suffix)
8b. DATE OF BIRTH (Mo/Day/Yr)
8c. MOTHER'S NAME PRIOR TO FIRST MARRIAGE (First, Middle, Last, Suffix)
8d. BIRTHPLACE (State, Territory, or Foreign Country)
9a. RESIDENCE OF MOTHER-STATE
9b. COUNTY
9c. CITY, TOWN, OR LOCATION
9d. STREET AND NUMBER
9e. APT. NO.
9f. ZIP CODE
9g. INSIDE CITY LIMITS? □ Yes □ No

FATHER

10a. FATHER'S CURRENT LEGAL NAME (First, Middle, Last, Suffix)
10b. DATE OF BIRTH (Mo/Day/Yr)
10c. BIRTHPLACE (State, Territory, or Foreign Country)

CERTIFIER

11. CERTIFIER'S NAME: ______________________
TITLE: □ MD □ DO □ HOSPITAL ADMIN. □ CNM/CM □ OTHER MIDWIFE
□ OTHER (Specify)______________
12. DATE CERTIFIED ____/____/______ MM DD YYYY
13. DATE FILED BY REGISTRAR ____/____/______ MM DD YYYY

INFORMATION FOR ADMINISTRATIVE USE

MOTHER

14. MOTHER'S MAILING ADDRESS: 9 Same as residence, or: State: City, Town, or Location:
Street & Number: Apartment No.: Zip Code:
15. MOTHER MARRIED? (At birth, conception, or any time between) □ Yes □ No
IF NO, HAS PATERNITY ACKNOWLEDGEMENT BEEN SIGNED IN THE HOSPITAL? □ Yes □ No
16. SOCIAL SECURITY NUMBER REQUESTED FOR CHILD? □ Yes □ No
17. FACILITY ID. (NPI)
18. MOTHER'S SOCIAL SECURITY NUMBER:
19. FATHER'S SOCIAL SECURITY NUMBER:

INFORMATION FOR MEDICAL AND HEALTH PURPOSES ONLY

MOTHER

20. MOTHER'S EDUCATION (Check the box that best describes the highest degree or level of school completed at the time of delivery)
□ 8th grade or less
□ 9th - 12th grade, no diploma
□ High school graduate or GED completed
□ Some college credit but no degree
□ Associate degree (e.g., AA, AS)
□ Bachelor's degree (e.g., BA, AB, BS)
□ Master's degree (e.g., MA, MS, MEng, MEd, MSW, MBA)
□ Doctorate (e.g., PhD, EdD) or Professional degree (e.g., MD, DDS, DVM, LLB, JD)

21. MOTHER OF HISPANIC ORIGIN? (Check the box that best describes whether the mother is Spanish/Hispanic/Latina. Check the "No" box if mother is not Spanish/Hispanic/Latina)
□ No, not Spanish/Hispanic/Latina
□ Yes, Mexican, Mexican American, Chicana
□ Yes, Puerto Rican
□ Yes, Cuban
□ Yes, other Spanish/Hispanic/Latina
(Specify)______________

22. MOTHER'S RACE (Check one or more races to indicate what the mother considers herself to be)
□ White
□ Black or African American
□ American Indian or Alaska Native (Name of the enrolled or principal tribe)__________
□ Asian Indian
□ Chinese
□ Filipino
□ Japanese
□ Korean
□ Vietnamese
□ Other Asian (Specify)__________
□ Native Hawaiian
□ Guamanian or Chamorro
□ Samoan
□ Other Pacific Islander (Specify)__________
□ Other (Specify)__________

FATHER

23. FATHER'S EDUCATION (Check the box that best describes the highest degree or level of school completed at the time of delivery)
□ 8th grade or less
□ 9th - 12th grade, no diploma
□ High school graduate or GED completed
□ Some college credit but no degree
□ Associate degree (e.g., AA, AS)
□ Bachelor's degree (e.g., BA, AB, BS)
□ Master's degree (e.g., MA, MS, MEng, MEd, MSW, MBA)
□ Doctorate (e.g., PhD, EdD) or Professional degree (e.g., MD, DDS, DVM, LLB, JD)

24. FATHER OF HISPANIC ORIGIN? (Check the box that best describes whether the father is Spanish/Hispanic/Latino. Check the "No" box if father is not Spanish/Hispanic/Latino)
□ No, not Spanish/Hispanic/Latino
□ Yes, Mexican, Mexican American, Chicano
□ Yes, Puerto Rican
□ Yes, Cuban
□ Yes, other Spanish/Hispanic/Latino
(Specify)______________

25. FATHER'S RACE (Check one or more races to indicate what the father considers himself to be)
□ White
□ Black or African American
□ American Indian or Alaska Native (Name of the enrolled or principal tribe)__________
□ Asian Indian
□ Chinese
□ Filipino
□ Japanese
□ Korean
□ Vietnamese
□ Other Asian (Specify)__________
□ Native Hawaiian
□ Guamanian or Chamorro
□ Samoan
□ Other Pacific Islander (Specify)__________
□ Other (Specify)__________

Mother's Name __________

Mother's Medical Record No. __________

26. PLACE WHERE BIRTH OCCURRED (Check one)
□ Hospital
□ Freestanding birthing center
□ Home Birth: Planned to deliver at home? 9 Yes 9 No
□ Clinic/Doctor's office
□ Other (Specify)______________

27. ATTENDANT'S NAME, TITLE, AND NPI
NAME: ______________ NPI:______
TITLE: □ MD □ DO □ CNM/CM □ OTHER MIDWIFE
□ OTHER (Specify)__________

28. MOTHER TRANSFERRED FOR MATERNAL MEDICAL OR FETAL INDICATIONS FOR DELIVERY? □ Yes □ No
IF YES, ENTER NAME OF FACILITY MOTHER TRANSFERRED FROM:
____

REV. 11/2003

MOTHER

29a. DATE OF FIRST PRENATAL CARE VISIT
____/____/____ (MM DD YYYY) □ No Prenatal Care

29b. DATE OF LAST PRENATAL CARE VISIT
____/____/____ (MM DD YYYY)

30. TOTAL NUMBER OF PRENATAL VISITS FOR THIS PREGNANCY
__________ (If none, enter A0".)

31. MOTHER'S HEIGHT ______ (feet/inches)

32. MOTHER'S PREPREGNANCY WEIGHT ________ (pounds)

33. MOTHER'S WEIGHT AT DELIVERY ________ (pounds)

34. DID MOTHER GET WIC FOOD FOR HERSELF DURING THIS PREGNANCY? □ Yes □ No

35. NUMBER OF PREVIOUS LIVE BIRTHS (Do not include this child)

- 35a. Now Living — Number ____ □ None
- 35b. Now Dead — Number ____ □ None

36. NUMBER OF OTHER PREGNANCY OUTCOMES (spontaneous or induced losses or ectopic pregnancies)

- 36a. Other Outcomes — Number ____ □ None

37. CIGARETTE SMOKING BEFORE AND DURING PREGNANCY
For each time period, enter either the number of cigarettes or the number of packs of cigarettes smoked. IF NONE, ENTER A0".

Average number of cigarettes or packs of cigarettes smoked per day.

	# of cigarettes		# of packs
Three Months Before Pregnancy	____	OR	____
First Three Months of Pregnancy	____	OR	____
Second Three Months of Pregnancy	____	OR	____
Third Trimester of Pregnancy	____	OR	____

38. PRINCIPAL SOURCE OF PAYMENT FOR THIS DELIVERY

- □ Private Insurance
- □ Medicaid
- □ Self-pay
- □ Other (Specify) ________

35c. DATE OF LAST LIVE BIRTH ____/____ (MM YYYY)

36b. DATE OF LAST OTHER PREGNANCY OUTCOME ____/____ (MM YYYY)

39. DATE LAST NORMAL MENSES BEGAN ____/____/____ (MM DD YYYY)

40. MOTHER'S MEDICAL RECORD NUMBER

MEDICAL AND HEALTH INFORMATION

41. RISK FACTORS IN THIS PREGNANCY (Check all that apply)

Diabetes
- □ Prepregnancy (Diagnosis prior to this pregnancy)
- □ Gestational (Diagnosis in this pregnancy)

Hypertension
- □ Prepregnancy (Chronic)
- □ Gestational (PIH, preeclampsia)
- □ Eclampsia

- □ Previous preterm birth
- □ Other previous poor pregnancy outcome (Includes perinatal death, small-for-gestational age/intrauterine growth restricted birth)
- □ Pregnancy resulted from infertility treatment-If yes, check all that apply:
  - □ Fertility-enhancing drugs, Artificial insemination or Intrauterine insemination
  - □ Assisted reproductive technology (e.g., in vitro fertilization (IVF), gamete intrafallopian transfer (GIFT))
- □ Mother had a previous cesarean delivery
  If yes, how many ________
- □ None of the above

42. INFECTIONS PRESENT AND/OR TREATED DURING THIS PREGNANCY (Check all that apply)

- □ Gonorrhea
- □ Syphilis
- □ Chlamydia
- □ Hepatitis B
- □ Hepatitis C
- □ None of the above

43. OBSTETRIC PROCEDURES (Check all that apply)

- □ Cervical cerclage
- □ Tocolysis

External cephalic version:
- □ Successful
- □ Failed

- □ None of the above

44. ONSET OF LABOR (Check all that apply)

- □ Premature Rupture of the Membranes (prolonged, 3 12 hrs.)
- □ Precipitous Labor (<3 hrs.)
- □ Prolonged Labor (3 20 hrs.)
- □ None of the above

45. CHARACTERISTICS OF LABOR AND DELIVERY (Check all that apply)

- □ Induction of labor
- □ Augmentation of labor
- □ Non-vertex presentation
- □ Steroids (glucocorticoids) for fetal lung maturation received by the mother prior to delivery
- □ Antibiotics received by the mother during labor
- □ Clinical chorioamnionitis diagnosed during labor or maternal temperature $\geq 38°C$ (100.4°F)
- □ Moderate/heavy meconium staining of the amniotic fluid
- □ Fetal intolerance of labor such that one or more of the following actions was taken: in-utero resuscitative measures, further fetal assessment, or operative delivery
- □ Epidural or spinal anesthesia during labor
- □ None of the above

46. METHOD OF DELIVERY

A. Was delivery with forceps attempted but unsuccessful?
□ Yes □ No

B. Was delivery with vacuum extraction attempted but unsuccessful?
□ Yes □ No

C. Fetal presentation at birth
- □ Cephalic
- □ Breech
- □ Other

D. Final route and method of delivery (Check one)
- □ Vaginal/Spontaneous
- □ Vaginal/Forceps
- □ Vaginal/Vacuum
- □ Cesarean
  If cesarean, was a trial of labor attempted?
  - □ Yes
  - □ No

47. MATERNAL MORBIDITY (Check all that apply) (Complications associated with labor and delivery)

- □ Maternal transfusion
- □ Third or fourth degree perineal laceration
- □ Ruptured uterus
- □ Unplanned hysterectomy
- □ Admission to intensive care unit
- □ Unplanned operating room procedure following delivery
- □ None of the above

NEWBORN

NEWBORN INFORMATION

48. NEWBORN MEDICAL RECORD NUMBER

49. BIRTHWEIGHT (grams preferred, specify unit)
__________ 9 grams 9 lb/oz

50. OBSTETRIC ESTIMATE OF GESTATION:
__________ (completed weeks)

51. APGAR SCORE:
Score at 5 minutes: __________
If 5 minute score is less than 6,
Score at 10 minutes: __________

52. PLURALITY - Single, Twin, Triplet, etc.
(Specify) __________

53. IF NOT SINGLE BIRTH - Born First, Second, Third, etc. (Specify) __________

54. ABNORMAL CONDITIONS OF THE NEWBORN (Check all that apply)

- □ Assisted ventilation required immediately following delivery
- □ Assisted ventilation required for more than six hours
- □ NICU admission
- □ Newborn given surfactant replacement therapy
- □ Antibiotics received by the newborn for suspected neonatal sepsis
- □ Seizure or serious neurologic dysfunction
- □ Significant birth injury (skeletal fracture(s), peripheral nerve injury, and/or soft tissue/solid organ hemorrhage which requires intervention)
- 9 None of the above

55. CONGENITAL ANOMALIES OF THE NEWBORN (Check all that apply)

- □ Anencephaly
- □ Meningomyelocele/Spina bifida
- □ Cyanotic congenital heart disease
- □ Congenital diaphragmatic hernia
- □ Omphalocele
- □ Gastroschisis
- □ Limb reduction defect (excluding congenital amputation and dwarfing syndromes)
- □ Cleft Lip with or without Cleft Palate
- □ Cleft Palate alone
- □ Down Syndrome
  - □ Karyotype confirmed
  - □ Karyotype pending
- □ Suspected chromosomal disorder
  - □ Karyotype confirmed
  - □ Karyotype pending
- □ Hypospadias
- □ None of the anomalies listed above

56. WAS INFANT TRANSFERRED WITHIN 24 HOURS OF DELIVERY? 9 Yes 9 No
IF YES, NAME OF FACILITY INFANT TRANSFERRED TO: __________

57. IS INFANT LIVING AT TIME OF REPORT? □ Yes □ No □ Infant transferred, status unknown

58. IS THE INFANT BEING BREASTFED AT DISCHARGE? □ Yes □ No

Mother's Name __________

Mother's Medical Record No. __________

Rev. 11/2003

NOTE: This recommended standard birth certificate is the result of an extensive evaluation process. Information on the process and resulting recommendations as well as plans for future activities is available on the Internet at: http://www.cdc.gov/nchs/vital_certs_rev.htm.