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An Examination of the Impact of Preconception Health on Adverse Pregnancy Outcomes through the Theoretical Lens of Reciprocal Determinism

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An Examination of the Impact of Preconception Health on Adverse Pregnancy Outcomes through the Theoretical Lens of Reciprocal Determinism

by

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Abstract

Statement of Purpose

The purpose of this study is to examine the impact of preconception health on adverse pregnancy outcomes through the theoretical lens of reciprocal determinism. Thus, this study aims to develop a preconception health conceptual framework that accounts for the interactive relationships among behavior, the environment, and the person.

Rationale for the Study

Women may not recognize a pregnancy until the first or second missed menstrual cycle, a full four to eight weeks or more after conception. Once a woman realizes the possibility of a pregnancy, it takes further time to confirm the pregnancy with a home pregnancy kit or a visit to the health care provider. In that time period, the woman may have unknowingly exposed her embryo to nutritional deficiencies, over-the-counter drugs, tobacco, alcohol, or other toxins. Because nearly half of all pregnancies are unintended, yielding about three million unintended pregnancies in the U.S. annually, there is a need to shift care to an earlier period in a woman's life cycle with greater potential to prevent birth defects and other adverse pregnancy outcomes, also known as preconception care.

The preconception health movement began with the rationale that many adverse pregnancy outcomes are determined prior to prenatal care initiation. Thus, in addition to prenatal care, the need for preconception health arose. The empirical literature makes a strong case for the benefit of individual preconception health components and their effects on adverse pregnancy outcomes. However, the actual effectiveness of collective

preconception health in reducing adverse pregnancy outcomes has not yet been demonstrated. In an effort to evaluate the impact of preconception health on maternal morbidity, infant morbidity, and infant mortality, this study examined the reciprocal relationships between environmental, personal, and preconception behavioral factors and their associations with adverse pregnancy outcomes.

Methods

A secondary data analysis was conducted using the Pregnancy Risk Assessment Monitoring System (PRAMS) data from 2005-2008 to test a preconception framework. Project 1 examined all variables in the preconception framework among the following states: Maine, New Jersey, Ohio, and Utah. Project 2 examined all variables except of two among all PRAMS-participating states. All of the variables in the proposed framework were derived from questions in the PRAMS survey or from PRAMS-linked birth certificate data. The research questions posed in this study were resolved through the path analyses of reduced and full iterations of the preconception framework in Projects 1 and 2.

Results

In Project 1, list-wise deletion of missing data resulted in a decrease from the original 27,933 participants to 12,239 participants. In Project 2, this action resulted in a decrease from the original 200,008 participants to 128,551 participants. The analysis of the reduced frameworks for both projects revealed extremely low R-squared values (1.1% or less). Subsequent analyses examining the full framework in Projects 1 and 2, as well as an additional post hoc analysis with supplementary PRAMS variables, resulted in R-squared values of 13.1%, 11.4%, and 30.5%, respectively.

Implications

This study examined the impact of preconception health behaviors on adverse pregnancy outcomes through the theoretical lens of reciprocal determinism. Preconception health behaviors alone accounted for a negligible portion of the variance associated with adverse pregnancy outcomes. As hypothesized, preconception health behaviors work in concert with environmental factors, personal influences, prenatal and natal factors. Significant predictors supported in the literature included lower socioeconomic status, pregnancy intention, pregnancy history, older maternal age, black maternal race, Hispanic ethnicity, overweight maternal BMI, tobacco use prior to pregnancy, maternal complications, hospitalization during pregnancy, later prenatal care initiation, fewer prenatal care visits, plurality, and cesarean section. Even so, there is a large portion of the variance in adverse pregnancy outcomes that is not accounted for, and further examination is required.

Chapter 1: Statement of the Problem

Introduction

Preconception care, or care prior to pregnancy, is an important aspect of women's health care. Preconception care may be defined as, "a set of interventions that aim to identify and modify biomedical, behavioral, and social risks to a woman's health or pregnancy outcome through prevention and management, emphasizing those factors that must be acted on before conception or early in pregnancy to have maximal impact" (Posner, Johnson, Parker, Atrash, & Biermann, 2006, p. S198). The goal of preconception care is to provide health promotion, screening, and interventions for the more than 62 million women of childbearing age in the United States (Johnson, 2006; U.S. Census Bureau, 2005).

Ideologic Shift from Prenatal Care

Prenatal care is generally described as the health care a woman receives during pregnancy (March of Dimes, 2009; U.S. Department of Health and Human Services [DHHS], 2009; Mayo Clinic, 2008). Prenatal care may address maternal education, counseling, and the teaching of basic parenting skills (U.S. National Library of Medicine & National Institutes of Health, 2009), and it typically includes the monitoring of a pregnancy for potential maternal or fetal problems that may occur (Hood, Parker, & Atrash, 2007). According to *Healthy People 2010,* about 74% of women obtain early and adequate prenatal care (U.S. Department of Health and Human Services [DHHS], 2000). However, prenatal care, even when initiated in early pregnancy, fails to prevent certain fetal development and maternal health risks. During fetal development, the fourth through the tenth week after conception is the most critical window in which the

fetus is susceptible to potential health problems. Usually, prenatal care begins in the eleventh or twelfth week of pregnancy, thus failing to prevent early embryonic developmental abnormalities and failing to reduce numerous health risks to the mother (CDC, 2006c). Therefore, preventive care prior to the earliest days of a pregnancy, or preconception care, must pave the way for more effective prenatal care and healthier pregnancies in the future.

Half of all infant deaths are attributed to four causes: 1) congenital malformations/birth defects; 2) disorders related to prematurity and low birth weight (LBW); 3) sudden infant death syndrome (SIDS); and 4) maternal complications of pregnancy (Arias, MacDorman, Strobino, & Guyer, 2003; Bennett & Kotelchuck, 2005). Research indicates that prenatal care alone is insufficient to effect necessary change in these contributors to infant mortality, and thus, other prevention strategies are needed, such as preconception care (U.S. Department of Health and Human Services [DHHS], 2000; Korenbrot, Steinberg, Bender, & Newberry, 2002).

Infant mortality is generally a primary focus, but mothers require attention, as well. In the United States, maternal mortality rates decreased by 99% in the 20th century, with 11.5 maternal deaths per 100,000 live births reported in 1999 (Berg, et al., 2003). Black women, however, are over four times more likely to die due to maternal illness than are white women (Association of State and Territorial Health Officials [ASTHO], 2006). Whereas maternal mortality is defined as the number of maternal deaths per 100,000 live births, maternal morbidity may be defined as illness or injury to the mother caused by, aggravated by, or associated with pregnancy, childbirth, or postpartum conditions within 42 days after giving birth (Reed, et al., 2000). Conditions associated with maternal morbidity range from pregnancy-induced hypertension to sepsis to obstetric complications (Boulvain, 2008; Geller, et al., 2004). In the United States, maternal morbidity affects nearly 1.7 million women annually, with 43% of

women experiencing some form of perinatal condition or complication (Danel, et al., 2003). Reducing maternal mortality and morbidity are national goals, and preconception care is one possible solution (ASTHO, 2006).

A History of Preconception Health

Ancient times. Preconception care is not a novel idea. The first known recorded history of preconception care was written in the 9th century B.C. (Plutarch, trans. 1932). Plutarch wrote of the ancient Spartans that their leader, Lycurgus, "ordered the maidens to exercise themselves with wrestling, running, and throwing the quoit and casting the dart, to the end that the fruit they conceived might, in strong and healthy bodies, take firmer root and find better growth" (Plutarch, trans. 1932, pp.59-60). Another ancient text is found in the Old Testament of the Bible, when an angel of the Lord appeared to Samson's mother and said, "…You have never been able to have any children, but very soon you will be pregnant and have a son…And even before he is born, you must not drink any wine or beer or eat any food forbidden by God's laws…" (Judges 13: 3-4; Contemporary English Version). These texts highlight preconception health components, such as physical exercise and avoidance of alcohol, to improve pregnancy outcomes. Written records about preconception care, from this point in time through the 18th century, are scarce.

The 19th and early 20th centuries. William Potts Dewees, an early American obstetrician and a pioneer in perinatal medicine, published several books about the medical conditions afflicting women and children. In 1825, William Potts Dewees stated in the *Treatise on the Physical and Medical Treatment of Children* that, "…the physical treatment of children should begin, as far as may be practicable, with the earliest formation of the embryo: it will, therefore, necessarily involve the conduct of the female, even before her marriage, as well as during the period of pregnancy" (Dewees, preface page ix). In 1902, the National Vital Statistics System was developed (Margolis, Cole, &

Kotch, 2005). For the first time, a figure for infant mortality in the entire United States was established (Margolis, Cole, & Kotch, 2005). In 1900, the infant mortality rate in the United States was 150 infant deaths per 1,000 live births (Margolis, Cole, & Kotch, 2005).

The 1970s. In 1979, the U.S. Department of Health, Education, and Welfare (DHEW) published a federal position paper acknowledging the need for a national shift in its approach to prevention (DHEW, 1979). This document proposed a comprehensive package of integrated services for women, including interconceptional care, prenatal care, perinatal care, child health care, services for handicapped children, and adolescent services (DHEW, 1979). For definitional purposes, "preconceptional" refers to a woman's health status prior to pregnancy, "periconceptional" refers to a woman's health status from the time immediately prior to conception through the period of fetal organ development, and "interconceptional" typically addresses a woman's health status between pregnancies, birth spacing, and intendedness of subsequent pregnancies (Freda, Moos, & Curtis, 2006).

The 1980s. The U.S. Surgeon General's Conference in the early 1980s on infant mortality related that the United States' ranking declined from 10th place in the 1960s to 19th place among 39 industrialized nations (Institute of Medicine [IOM], 1985). To improve pregnancy outcomes, leaders began to initiate several national programs (Atrash, et al., 2008; National Healthy Mothers Healthy Babies Coalition [HMHB], 2007). In 1981, the "Healthy Mothers Healthy Babies" coalition was formed by the American College of Obstetricians and Gynecologists (ACOG), the American Academy of Pediatrics (AAP), the March of Dimes (MOD), the American Nurses Association (ANA), the National Congress of Parents and Teachers, and the U.S. Public Health Service (HMHB, 2007). The purpose of this coalition was to improve maternal and child health through education and collaborative partnerships (HMHB, 2007). In 1985, the United

States Public Health Service included preconception care in the landmark publication, *Preventing Low Birth Weight* (IOM, 1985). This report recognized that preconception opportunities were often overlooked in favor of prenatal care, and the IOM Committee recommended prepregnancy risk identification, counseling, risk reduction, and health education as part of a restructuring of the perinatal prevention paradigm (IOM, 1985). The AAP and the ACOG, in partnership with the MOD, published *Guidelines for Perinatal Care* in 1983 (AAP & ACOG, 1983). These guidelines included preconception care in an appendix, stating, "Preparation for parenthood should begin prior to conception. At the time of conception, the couple should be in optimal physical health and emotionally prepared for parenthood" (p. 257). In 1989, the federally appointed Expert Panel on the Content of Prenatal Care endorsed the preconception health care visit as possibly the single most important health care visit in regards to its effect on pregnancy (U.S. Department of Health and Human Services [DHHS], 1989). The Panel recommended health coverage and reimbursement for preconception visits during family planning as part of prenatal care (DHHS, 1989). The Panel also iterated that optimal preconception care occurs when services are provided as part of general prevention care or during primary care visits for other medical needs (DHHS, 1989). This approach integrates preconception care into opportunities provided by the existing health care system, and is therefore commonly known as "opportunistic care" (Freda, Moos, & Curtis, 2006).

The 1990s. Published in 1990, *Healthy People 2000* recommended to increase the proportion of primary care clinicians who provide age-appropriate preconception care and counseling to at least 60%, an objective for which no previous baseline data was reported (U.S. Department of Health and Human Services [DHHS], 1991). This recommendation was later omitted from *Healthy People 2010* due to measurement issues (DHHS, 2000, Moos 2002). Another national program began in 1991, the Healthy

Start Initiative (National Healthy Start Association [NHSA], 2008). This program was implemented in urban and rural communities with infant mortality rates 1.5-2.5 times the national average, and it aimed to develop community-based approaches to reduce infant mortality rates and improve the health of women and their families (NHSA, 2008). In 1993, the MOD Birth Defects Foundation published *Toward Improving the Outcome of Pregnancy: The 90s and Beyond* (MOD, 1993). This document introduced "reproductive awareness" as the primary health promotion strategy to improve pregnancy outcomes, and it addressed the need to include males as part of the preconceptional effort (MOD, 1993). The MOD also called for professional standards to address opportunistic health care to reach all women from menarche to menopause with preconceptional messages (MOD, 1993). In 1995, the ACOG published its first technical bulletin regarding preconception care and recommended a thorough and systematic identification of risks, patient-oriented education, and the initiation of preconception interventions (ACOG, 1995). However, the organization cautioned against over-promising the benefits of preconception care to patients and providers, noting that preconceptional services do not guarantee positive pregnancy outcomes (ACOG, 1995).

The 21st century. By 2002, the infant mortality rate dramatically diminished to 7 infant deaths per 1,000 live births; however, this infant mortality rate ranked the United States as 28th among 39 industrialized nations (Bennett & Kotelchuck, 2005). The percentage of women who accessed early and adequate prenatal care increased from 76% in 1980 to nearly 84% in 2004 (NCHS, 2007). There was a corresponding drop in infant mortality from 12.6 deaths per 1,000 live births in 1980 to 6.8 deaths per 1,000 live births in 2004 (NCHS, 2007). However, other countries made similar progress, and the United States dropped further in the worldwide infant mortality rankings to 29th among 39 industrialized nations in 2004 (Martin, Hamilton, Sutton, Ventura, Menacker, & Kirmeyer, 2006).

The AAP and ACOG recognized the growing importance of preconception care in their fifth edition of the *Guidelines for Perinatal Care* (AAP & ACOG, 2002). In previous editions, preconception care shifted from an appendix item to part of the main text (Freda, Moos, & Curtis, 2006). In the fifth edition, however, the guidelines highlighted the need for integration of preconception health promotion into all health encounters during a woman's reproductive years (AAP & ACOG, 2002). In 2004, the Preconception Health and Health Care Initiative was launched by the Centers for Disease Control and Prevention (CDC) Workgroup on Preconception Health and Health Care, representing 22 CDC programs dealing with maternal and child health, as well as national experts and representatives of over 35 national, state, and local organizations (Atrash, 2008). As part of the Initiative, national experts on a Select Panel on Preconception Care developed *Recommendations on Preconception Health and Health Care* in 2005. These recommendations aimed to achieve four goals: 1) improve preconceptional knowledge, attitudes, and behaviors of women and men; 2) assure that all women of reproductive age in the United States receive preconception health services enabling them to achieve optimal health prior to pregnancy; 3) reduce risks indicated by previous adverse pregnancies through interconceptional interventions; and 4) reduce disparities in adverse pregnancy outcomes (CDC, 2006). In 2006, the Panel prompted the development of ongoing workgroups in the areas of clinical, public health, consumer, policy, and finance to develop the Initiative's goals and the Panel's recommendations further (Atrash, 2008). The CDC convened national preconception care summits in 2005 and 2007 to disseminate and share preconception care improvements and research developments.

Indeed, preconception is not a novel concept. However, even with all of this historical background, key players, and presumed grand ideas, the concept of preconception health has not been implemented in the mainstream population of the

United States. Even with a vast amount of research on the individual components of preconception health, there is still no evidence of the effectiveness of collective preconception health on adverse pregnancy outcomes.

Biologic Plausibility

An understanding of human development is critical to understanding the importance of preconception care. Pregnancy is typically discussed in terms of time, such as first, second, and third trimesters. However, in terms of development, pregnancy is more commonly divided into germinal, embryonic, and fetal periods (Stassen Berger, 2005). The germinal period takes place between fertilization and day 14 of development (Stassen Berger, 2005). At this stage, the developing human being, known as a zygote, is characterized by rapid cell division and the beginning stages of cell differentiation (Stassen Berger, 2005). The embryonic period follows, from day 14 through day 56, during which the developing embryo (previously known as the zygote) forms the basic structures of the body (Stassen Berger, 2005). The neural tube develops by day 22, which becomes the central nervous system consisting of the brain and the spinal column (Greenberg, Bruess, & Conklin, 2007). In the fourth week, the head begins to develop, and the formation of eyes, ears, nose, and mouth begins (Stassen Berger, 2005). By day 23, the beginnings of a cardiovascular system are present and the rudimentary heart begins to beat (Greenburg, Bruess, & Conklin, 2007). Weeks five through seven mark the development of arms, distinct fingers, legs, and distinct toes with the beginnings of a skeletal structure (Stassen Berger, 2005). By day 56, the embryo weighs approximately one-thirtieth of an ounce, or about one gram, and it is about one inch in length (Stassen Berger, 2005). At this time, facial features and organs have formed, and the embryo has all the body parts (except for sex organs) of a human being (Stassen Berger, 2005). During the fetal period, the embryo (now known as the fetus) grows in size, as do the developing organs (Stassen Berger, 2005).

Cell organization, cell differentiation, and organogenesis, therefore, typically occur between days 15 and 56, introducing a critical window for embryonic development. During this time frame, the embryo is sensitive to teratogenic activity that gives rise to birth defects (Bennett & Kotelchuck, 1995). Many nutritional, drug-related, or viral exposures may be detrimental to a developing embryo (Bennett & Kotelchuck, 1995). Major organ systems of the embryo may be affected by these external influences (Bennett & Kotelchuck, 1995).

Women may not recognize a pregnancy until the first or second missed menstrual cycle, a full four to eight weeks or more after conception. Once a woman realizes the possibility of a pregnancy, it takes further time to confirm the pregnancy with a home pregnancy kit or a visit to the health care provider. In that time period, the woman may have unknowingly exposed her embryo to nutritional deficiencies, over-the-counter drugs, tobacco, alcohol, or other toxins. According to a study conducted in a family practice residency clinic, 52% of 136 women with a negative pregnancy test had a medical condition known to be a risk factor for adverse pregnancy outcomes (Jack, et al., 1995). Because nearly half of all pregnancies are unintended, yielding about three million unintended pregnancies in the U.S. annually (DHHS, 2000), there is a need to shift care to an earlier period in a woman's life cycle with greater potential to prevent birth defects and other adverse pregnancy outcomes, also known as preconception care (Bennett & Kotelchuck, 2005).

Intent of the Proposed Study

Research indicates that prenatal care alone is insufficient to effect necessary change in infant mortality, thus explicating the need for other prevention strategies, such as preconception care (DHHS, 2000; Korenbrot, Steinberg, Bender, & Newberry, 2002). The idea of preconception health derives from ancient times and it is not a new idea to the United States. Yet, preconception health is only now being considered as

supplemental prevention to prenatal care. Preconception health, however, does not occur in a vacuum. The literature fails to demonstrate the effectiveness of preconception health as a whole on reducing adverse pregnancy outcomes, especially in the context of environmental and personal influences.

Pregnancy Risk Assessment Monitoring System. The proposed study is based upon a secondary data analysis using Pregnancy Risk Assessment Monitoring System (PRAMS) surveillance data. The PRAMS project, a product of the CDC, collects cross-sectional, population-based data from 37 states, one city (New York City), and an American Indian tribal territory regarding maternal experiences before, during, and shortly after pregnancy to inform the development of state health programs designed to improve maternal and infant health (CDC, 2009). Some states do not participate in PRAMS (Table 3). Most of these states have similar systems, and others may choose not to participate due to internal staffing or resource issues (D'Angelo, D.V., November 13, 2009). Several states expressed interest in applying for the next PRAMS funding cycle in 2011 (D'Angelo, D.V., November 13, 2009).

The PRAMS survey aims to target all pregnancies resulting in a live-born infant in the United States with the following exclusions:

1) out-of-state births to residents;

2) in-state births to nonresidents;

3) infants whose birth certificate lacks a maternal last name;

4) those birth certificates processed more than six months after the birth;

5) all but one infant associated with a multiple gestation;

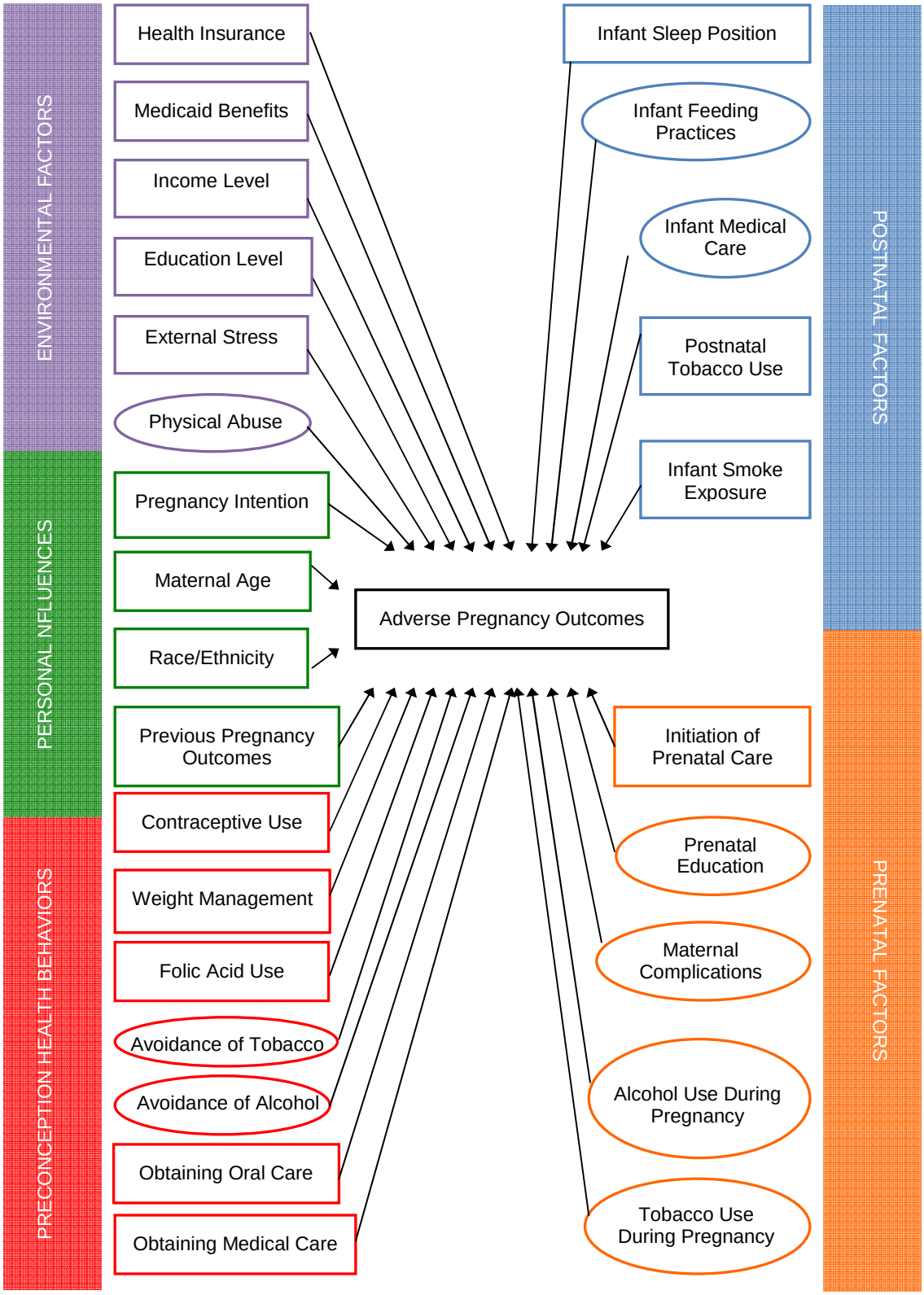
6) adopted infants; and

7) surrogate births.

The sampling frame consists of all mothers that represent the population eligible for study inclusion. Due to inaccessibility of such a sampling frame list, the operational

sampling unit consists of all infants born alive within the specified state to resident mothers during a specific time frame, and birth certificates are used as the operational sampling frame, which automatically exclude stillbirths, fetal deaths, and induced abortions. From the remaining eligible birth certificates, a stratified systematic probability sample of 100 to 250 mothers is drawn every month in each state. States generally oversample for infants with low birth weight, and as the choice for dual stratification variables is limited to birth certificate information, many states opt to stratify by race or ethnicity.

The PRAMS questionnaire was first developed in 1987. The instrument was then edited and revised by the CDC with state participation until April 2004 when the phase five questionnaire was developed that is in use today. The PRAMS survey continuously undergoes assessment and evaluation to revise item material and to meet the public health needs of each state. In the phase five PRAMS questionnaire, there are three types of questions: core questions, standard state questions, and state-specific questions. Core questions are used by every participating state. Standard state questions are optional questions of interest for each state that were developed by the CDC with significant state and researcher input. Currently, states may choose from 185 standard questions for their surveys. In addition, states may develop their own specific questions beyond the standard state questions that do not address topics of general interest. Core questions remain fairly constant throughout the study periods, but the selection of standard questions and state-specific questions by individual states may vary from year to year.



[Note: All exogenous variables are allowed to covary.]

Figure 1. The preconception health framework.

Purpose. The purpose of this study is to examine the impact of preconception health on adverse pregnancy outcomes through the theoretical lens of reciprocal determinism. Thus, this study aims to develop a preconception health conceptual framework that accounts for the interactive relationships among behavior, the environment, and the person (Figure 1). All of the variables in the proposed framework are derived from questions in the PRAMS survey or from PRAMS-linked birth certificate data. The framework and variations of the framework will be analyzed using structural equation modeling.

Research Questions

1. What is the relationship between preconception health behaviors and adverse pregnancy outcomes among women of reproductive age?
    a. To what extent do preconception health behaviors explain the variance associated with adverse pregnancy outcomes?
    b. Which factors are most strongly associated with adverse pregnancy outcomes?
2. What is the relationship among preconception health behaviors, prenatal factors, postnatal factors, personal influences, environmental factors, and adverse pregnancy outcomes among women of reproductive age?
    a. To what extent does the entire framework explain the variance associated with adverse pregnancy outcomes?
    b. Which factors are most strongly associated with adverse pregnancy outcomes?

Null Hypotheses

H_O1: Preconception health behaviors are not predictive of adverse pregnancy outcomes.

H_O2: The preconception health framework is not adequate to account for the

variance associated with adverse pregnancy outcomes among women of reproductive age.

Alternative Hypotheses

H_A1a: Preconception health behaviors alone explain about 10% of the variance associated with adverse pregnancy outcomes.

H_A1b: Normal BMI and contraceptive use are the strongest protective factors for adverse pregnancy outcomes.

H_A2a: The entire framework accounts for about 95% of the variance associated with adverse pregnancy outcomes.

H_A2b: Insurance status, income, and pregnancy intention are the strongest \ predictors of adverse pregnancy outcomes. Early initiation of prenatal care, normal BMI, and contraceptive use are the strongest protective factors against adverse pregnancy outcomes.

Delimitations

Delimitations of a study describe the population to which study results may be generalized (Locke, et al., 2000). The delimitations for this study are as follows:

1. Results are only generalizable to the mothers of live-born infants born between 2005 and 2008 who are part of the data set. Therefore, this study does not represent all women who became pregnant during this time frame, but only those who delivered a live, viable infant.
2. Results are only generalizable to the mothers of live-born infants born in one of the five states in Project 1 or one of the PRAMS-participating states in Project 2. In Project 1, datasets from Maine, New Jersey, Ohio, Utah, and Vermont will be analyzed, as these are the only five states that address all of the variables included in the proposed preconception health framework. Most of these states rank among the

lowest infant mortality in the United States. Thus, to enhance generalizability, Project 2 involves the analysis of datasets from all PRAMS-participating states. The Project 2 analyses eliminate two constructs of the preconception health framework due to instrumentation limitations: obtaining oral care and obtaining medical care. Due to the selection of these ten states, the results of this study are not generalizable to the entire nation.

3. Results are only generalizable to mothers of live-born infants who are residents of the states included in the study and who gave birth within those states.
4. Results are only generalizable to mothers of live-born infants who did not adopt or have a surrogate give birth to the baby.

Limitations

Limitations of a study describe the restrictive conditions or inherent weaknesses of the study design (Locke, et al., 2000). The limitations for this study are as follows:

1. This study relies on self-reported data, which may be subject to potential sources of error.
2. This study uses data about preconception behaviors several months following delivery. This extended time frame may introduce recall bias. A sub-analysis will be conducted to determine the effect of recall bias.
3. This study is limited in the testing of validity and psychometric properties of the PRAMS questionnaire.
4. The core section of this study limits the examination of domestic violence to physical violence, excluding the examination of emotional or sexual violence.
5. This study is limited to the items and scaling inherent in the PRAMS

questionnaire, with noted exclusion of items regarding maternal narcotic/amphetamine/marijuana use, genetic testing, maternal sexually transmitted infections, birth defects, and postnatal insurance status.

6. This study is limited to the core items of the PRAMS data, and it is also limited to the standard state items used by only certain states.
7. This study may introduce social desirability bias, because some participants may be hesitant to report on behaviors perceived as unhealthy or harmful to a pregnancy.

Definition of Terms

Body Mass Index – weight in kilograms divided by the square of the height in meters

Folic Acid – one of the water-soluble B vitamins, commonly found in leafy greens, legumes, and fortified cereal products, which aids in the synthesis of DNA and RNA; lack of adequate folic acid during pregnancy increases the risk of neural tube defects, such as spina bifida or anencephaly

Interconception Health – a woman's health status between pregnancies, birth spacing, and intendedness of subsequent pregnancies

Periconception Health – a woman's health status from the time immediately prior to conception through the period of fetal organ development

Preconception Care – a set of interventions that aim to identify and modify biomedical, behavioral, and social risks to a woman's health or pregnancy outcome through prevention and management, emphasizing those factors that must be acted on before conception or early in pregnancy to have maximal impact

Preconception Health – a woman's health status prior to pregnancy

Opportunistic Care - integrating preconception care into opportunities provided by the existing health care system

Chapter 2: Literature Review

Review of Literature

Preconception health encompasses many components, and yet it lacks focus and substance in the empirical literature. This chapter provides background on preconception health components, the association of these components with adverse pregnancy outcomes, the theoretical underpinning of the proposed preconception health framework, and gaps in the literature.

Preconception Health Components

In the past 30 years in the United States, lead organizations and agencies have discussed, researched, and attempted to implement preconception health (Atrash, 2008; Atrash, et al., 2008; National Healthy Start Association, 2008; National Healthy Mothers Healthy Babies Coalition, 2007; Centers for Disease Control and Prevention [CDC], 2006; American Academy of Pediatrics [AAP] & American College of Obstetricians and Gynecologists, 2002; 1983; U.S. Department of Health and Human Services [DHHS], 2000; 1991; 1989; Institute of Medicine, 1985; ACOG, 1995; March of Dimes [MOD], 1993). Even so, there are still no standardized guidelines for preconception health components today. A search of the literature revealed varying preconception health components as promoted by the following organizations: 1) American Academy of Family Physicians (AAFP) (professional organization); 2) ACOG (professional specialist organization); 3) CDC (federal organization); and 4) MOD (not-for-profit organization) (Brundage, 2002; ACOG, 2007; CDC, 2006; CDC, 2006b; MOD, 2009a; MOD, 2009b; MOD, 2008). These organizations promote preconception health to the general public,

professionals and researchers, or both, and these resources were combined for the purpose of comparison in this study (Table 1).

Table 1. Preconception health components promoted by different organizations.

Preconception Health Components	**AAFP[a]**	**ACOG[b]**	**CDC[c]**	**MOD[d]**
Folic acid supplementation	X	X	X	X
Weight management				
Obesity management	X	X	X	X
Underweight management	X	X		X
Nutrition			X	
Fruits/Vegetables		X		X
Whole grains		X		X
Low-fat dairy		X		X
Exercise: 30 minutes most days a week		X		X
Smoking cessation	X	X	X	X
Avoidance of alcohol	X	X	X	X
Avoidance of narcotics, amphetamines, and marijuana	X	X		X
Oral health care			X	X
Medical health care	X	X	X	X
Diabetes management	X	X	X	X
Epilepsy management	X	X	X	
Hypertension management	X	X	X	X
Asthma management			X	X
Thyroid management			X	X
Maternal PKU screening			X	X
Prescription medications	X	X	X	X
Over-the-counter medications		X	X	X

Preconception Health Components	AAFP[a]	ACOG[b]	CDC[c]	MOD[d]
Sexually Transmitted Infection (STI) screening	X	X	X	X
Immunizations	X		X	X
Family history	X	X		X
Genetic testing	X	X		X
Assessing previous pregnancy outcomes		X		X
Avoidance of toxic substances	X	X	X	X
Cat litter	X		X	X
Garden soil	X			
Raw meat	X			X
Occupational exposures	X		X	
Household chemicals	X	X	X	X
Excess fish consumption				X
High doses vitamin A	X	X		
High doses vitamin D	X			
Caffeine	X			X
Avoidance of domestic violence	X	X	X	
Avoidance of stress	X			X
Avoidance of hyperthermia (e.g., hot tubs)	X			X
Frequent handwashing	X			X
a = American Academy of Family Physicians; b = American College of Obstetricians and Gynecologists; c = Centers for Disease Control and Prevention; d = March of Dimes				
Compiled from the following sources: (CDC, 2006; 2006b); (MOD, 2009a; 2009b; 2008); (ACOG, 2007); (Brundage, 2002).				

These preconception health components promoted by AAFP, ACOG, CDC, and MOD will be defined and addressed in relation to their effects on adverse pregnancy outcomes.

Adverse pregnancy outcomes. A discussion of adverse pregnancy outcomes is essential to an understanding of this study. Adverse pregnancy outcomes are

commonly categorized as maternal morbidity (complications, illness, or injury), maternal mortality (death), infant morbidity, and infant mortality. In the PRAMS data collection, only live women were included in the survey process (CDC, 2009). Therefore, maternal mortality will be excluded as an adverse pregnancy outcome in this study. The following chapter will discuss fetal, infant, and maternal complications and infant mortality in relation to preconception characteristics.

Prior to this discussion, it is important to understand the distinctions between low birth weight, preterm birth, and small for gestational age categorization. Babies born weighing less than five pounds, eight ounces, or 2500 grams, are typically considered to be low birth weight (LBW), which affects one in fourteen babies born in the U.S. each year (MOD, 2009d). Babies born weighing less than three pounds, five ounces, or 1,500 grams, are usually considered to be very low birth weight (VLBW), and babies born less than two pounds, three ounces, or 1,000 grams, are considered to be extremely low birth weight (ELBW) (Stevens, Lynm, & Glass, 2002). Immediate and long-term complications due to low birth weight may include the following conditions:

- Respiratory dysfunction may occur, such as respiratory distress syndrome (RDS) due to surfactant deficiency (difficulty with breathing) or apnea of prematurity (short episodes without breathing).
- Hypothermia due to a higher body surface area: body weight ratio and decreased body fat may result in hypoglycemia, apnea, increased oxygen consumption, or metabolic acidosis (excessive acidity of the blood).
- Fluid and electrolyte imbalances due to insensible water loss or impaired renal function may result in dehydration, fluid overload, hypernatremia (elevated blood sodium level), hyponatremia (low blood sodium level), hyperkalemia (elevated blood potassium level), hypocalcemia (low blood calcium level), hypermagnesemia (elevated blood magnesium level); or impaired tolerance of

free water, bicarbonate resorption, potassium secretion, or urinary concentrating capacity.

- Polycythemia (too many blood cells) or inadequate liver function may result in hyperbilirubinemia (elevated blood bilirubin levels). Low levels of bilirubin are generally not a concern, but large amounts of bilirubin may cause seizures and brain damage, also known as a condition called kernicterus.
- Anemia (too few red blood cells) may result from hemorrhage, phlebotomy, decreased red blood cell production, or hemolysis. Treatment typically involves blood transfusions.
- Impaired nutrition due to gut immaturity with decreased motility; enzyme deficiencies; increased risk of necrotizing enterocolitis (inflammation of the colon and small intestine); delayed enteric (tube) feeding due to respiratory disease or patent ductus arteriosus (heart problem increasing the risk of infection or inflammation of the arteries; and increased caloric needs may result in feeding difficulties or slow rates of weight gain.
- Infection increases due to immunologic immaturity and prolonged invasive treatments (e.g. – increased use of endotracheal tubes, intravascular catheters, and prolonged and recurrent use of antibiotics).
- Neurologic problems may occur, such as intraventricular hemorrhage (bleeding in the brain in the area where cerebrospinal fluid is produced), periventricular leukomalacia (death of white matter in the brain in an area heavily involved in motor control), and increased long term risk for cerebral palsy, developmental delay, or learning disabilities.
- Opthalmic complications may include retinopathy of prematurity (an eye disease that may result in retinal detachment) or strabismus (crossed eyes).

- Hearing deficits (University of California, San Francisco Children's Hospital, 2004).

Low birth weight infants may be classified into two categories: 1) infants experiencing normal growth, but born too early, also known as preterm; or 2) infants with less growth than expected for a given age, whether born preterm or term, also known as small for gestational age (SGA) (McGuire & Fowlie, 2005).

About two-thirds of all low birth weight infants are preterm (McGuire & Fowlie, 2005). Preterm delivery is characterized as labor beginning before 37 weeks of gestation, and about one out of every ten babies is born preterm in the United States each year (ACOG, 2009b). Preterm birth is a leading cause of infant morbidity and mortality (Martin, et al., 2003), accounting for more than 70% of neonatal deaths and almost half of all long-term neurological disabilities (Mathews, Menacker, & MacDorman, 2004). Preterm labor complications of the fetus include sensory, respiratory, nervous system, and digestive problems (ACOG, 2009b). Preterm delivery generally results in the need for infant resuscitation and ventilator support in neonatal intensive care units (NICUs), which dramatically increases health care costs (Lockwood, 2003). In 2005 in the United States, preterm births resulted in medical care, lost household and labor market productivity, and early intervention service costs exceeding $26.2 billion (IOM, 2007). The causes of preterm birth are still unknown (Williamson, et al., 2008). Spontaneous preterm labor or spontaneous premature rupture of the membranes contribute to the majority of preterm births (McGuire & Fowlie, 2005). However, increased rates of preterm delivery are also associated with multiple pregnancies, assisted reproduction, and maternal and fetal complications (McGuire & Fowlie, 2005). In the United States, the percentage of preterm births increased from 11.6% in 2000 to 12.7% in 2005 in the United States (IOM, 2007). Of these, 2.03% of births were classified as very preterm (less than 32 weeks of gestation), and 9.1% of births were

classified as infants born in the late preterm period (34-36 weeks of gestation) (MacDorman & Mathews, 2008). Increases in the percentage of preterm births are evident among multiple and singleton births alike (Martin, et al., 2007). Even though very preterm and late preterm births accounted for 2% and 9% of births in 2005 respectively, very preterm births were associated with over one-half of all infant deaths and late preterm births were associated with three times the infant mortality rate for term births (those births between 37 and 41 weeks of gestation) (MacDorman & Mathews, 2008). Costs for early intervention services increase with decreasing gestational age (Clements, et al., 2007). In 2003, mean cost per infant between 24 and 31 weeks gestational age was $5,393 compared with $1,578 for infants between 32 and 36 weeks gestation and $725 for infants born at term (Clements, et al., 2007). In the same year, neonatal inpatient costs ranged from $11,000 to $18,000 per preterm birth compared with $1,300 to $1,900 per term birth (Schmitt, Sneed, & Phibbs, 2006; Gilbert, Nesbitt, & Danielsen, 2003).

Small for gestational age infants, resulting from constitutional small stature or intrauterine growth restriction (IUGR), are commonly defined as preterm or term infants with a birth weight below the 10^{th} percentile, or more than two standard deviations below the mean, for gestational age with abdominal circumference below the 2.5^{th} percentile (Eichenwald, 2009; AAFP, 1998). Infants below the third percentile for gestational age are at greatest risk of morbidity and mortality (Smith, 2005). About 70% of SGA infants are etiologically small and are at less risk of complications than the remaining 30% of SGA infants who have pathologic causes resulting from genetic, metabolic, or environmental influences (Smith, 2005; Stevens, Lynm, & Glass, 2002; Ott, 1988). Maternal factors impairing fetal growth may include genetic size, extreme reproductive age, parity, race, socioeconomic status, malnutrition, chronic disease, exposures to teratogens, heart disease, renal disease, hypertension, pulmonary disease,

hemoglobinopathies (genetic red blood cell defects), collagen-vascular disease, diabetes, multiple gestation, uterine anomalies, thrombotic disease (blood clotting disorder), high altitude environment, smoking, and cocaine (Smith, 2005; Lee, et al., 2003). Fetal factors impairing growth may include constitution (genetic makeup), chromosomal abnormality, malformations of the central nervous system, skeletal malformations, gastroschisis (abdominal wall defect), and congenital infections, such as toxoplasmosis, cytomegalovirus, rubella, or herpesvirus (Smith, 2005). IUGR fetuses may be classified as symmetric or asymmetric based upon morphologic characteristics (Hadlock, 2000). Symmetric IUGR cases are proportionately small, and they generally result from chromosomal abnormalities or infection (Hadlock, 2000). Asymetrical IUGR cases are thought to result from placental insufficiency, and therefore malnutrition, in the late second or early third trimester (Hadlock, 2000). Placental risk factors for SGA may include vascular malformations, chorioangioma (vascular tumor of the placenta), infarction, abruption, previa, and abnormal trophoblast invasion (Smith, 2005). With this type of IUGR, the head and long bones remain relatively normal in size, whereas the body is disproportionately smaller (Hadlock, 2000). Neonatal complications of IUGR may include perinatal asphyxia (lack of oxygen), meconium aspiration (respiration of the first fetal feces), hypoglycemia (low blood sugar), thrombocytopenia (platelet disorder), altered immunity, abnormal temperature regulation, pulmonary hemorrhage, persistent pulmonary hypertension of the newborn (PPHN) (disorder of the fetal circulatory system), hypocalcemia (low serum calcium levels), and mortality (Kendig, 2007; Smith, 2005). Long-term effects of fetal growth restriction may include delayed growth in childhood, short stature, propensity for obesity, and an increased risk of hypertension and type-2 diabetes in adulthood (Eichenwald, 2009). A triangulation of low birth weight, preterm delivery, and small for gestational age variables will be used in this study. Other adverse pregnancy outcomes used in this study include length of maternal hospital stay,

length of infant hospital stay, use of the Neonatal Intensive Care Unit (NICU), and infant mortality.

Folic acid supplementation. Folate (naturally occurring folic acid) is a water-soluble B vitamin that can be ingested in the diet from dark green leafy vegetables, beans and legumes, citrus fruits, whole grains, poultry, pork, shellfish, and liver (National Institutes of Health [NIH] & U.S. National Library of Medicine [NLM], 2009). Folic acid works with vitamin B_{12} and vitamin C in the use and synthesis of protein, the formation of red blood cells, and the production of deoxyribonucleic acid, or DNA, which carries genetic information (NIH & NLM, 2009). Because this vitamin is water-soluble, it is not stored in the fat deposits of the body and unused folate exits the body through the urine on a daily basis (NIH & NLM, 2009). In 1998, the Food and Drug Administration (FDA) began requiring folic acid fortification of enriched cereal-grain products at a level of 140 micrograms/100 grams to ensure adequate folic acid consumption (FDA, 1996). This recommendation was intended to provide the average person in the United States with an additional 100 micrograms of folic acid per day (Yetley & Radar, 2004; Lewis, Crane, Wilson, & Yetley, 1999; FDA, 1993). According to the National Health and Nutrition Examination Survey (NHANES), the adjusted geometric mean consumption of folic acid from fortified foods was 128 micrograms per day (95% CI: 123, 134 micrograms per day) among 1,685 nonpregnant women between 15 and 49 years of age (Quan-He, et al., 2007). Other studies demonstrate that fortified foods may provide as much as 200 micrograms of additional folic acid per day (Dietrich, Brown, & Block, 2005; Quinlivan & Gregory, 2003; Choumenkovitch, et al., 2002; Rader, Weaver, & Angyal, 2000). Regardless, the 1998 folic acid fortification of food resulted in increased average serum folate levels (Ganji & Kafai, 2006; Pfeiffer, et al., 2005; CDC, 2000) and a decreased prevalence of neural tube defects by 26%, which varied by race and ethnicity (Williams, et al., 2005; CDC, 2004c). Folic acid levels typically range between 3 and 17

nanograms/milliliter (National Institutes of Health and U.S. National Library of Medicine, 2009). Among nonpregnant women between 15 and 44 years of age, median serum folate levels increased from 4.8 nanograms/milliliter during the 1988-1994 NHANES III study period to 13.0 nanograms/milliliter during the 1999-2000 NHANES study period (CDC, 2007e). However, folate serum levels decreased to 11.4 and 10.6 nanograms/milliliter in the 2001-2002 and 2003-2004 study periods, respectively (CDC, 2007e). The largest decrease was noted among non-Hispanic whites (16%), but in all study periods, the lowest median folate serum levels were detected among non-Hispanic blacks (CDC, 2007e). Between 2005 and 2006, the prevalence of low blood folate levels (less than 3 nanograms/milliliter) was 0.5% among U.S. women of childbearing age (McDowell, et al., 2008). For comparison, between 2003 and 2005, the prevalence of spina bifida (the most common neural tube defect) was 2.00 per 10,000 live births among infants with non-Hispanic white mothers, 1.96 per 10,000 live births among infants with Hispanic mothers, and 1.74 per 10,000 live births among infants with non-Hispanic black mothers (Boulet, et al., 2009). To ensure adequate folic acid consumption, folic acid supplements (man-made folate) are often recommended to supplement dietary intake (CDC, 2008).

Numerous studies demonstrate the efficacy of folic acid in the reduction of neural tube defects (Czeizel & Dudas, 1992; Werler, Shapiro, & Mitchell, 1993; Shaw, et al., 1995; Czeizel, Toth, & Rockenbauer, 1996; Czeizel, Dobo, & Vargha, 2004; Goh, Bollano, Einarson, & Koren, 2006; Thompson, et al., 2003; Vollset, et al., 2005). The majority of these studies recommend the use of folic acid taken three months prior to conception for optimal benefit (Czeizel & Dudas, 1992; Werler, Shapiro, & Mitchell, 1993; Shaw, et al., 1995; Czeizel, Toth, & Rockenbauer, 1996; Thompson, et al., 2003). The ACOG, the Institute of Medicine (IOM), the Department of Health and Human Services (DHHS), and the CDC have integrated the use of folic acid into their guidelines

for several decades (Lumley, Watson, Watson, & Bower, 2001). Neural tube defects may be classified as major birth defects of the brain or spinal cord, which occur during the formation of the neural tube during the first few weeks of pregnancy (CDC, 2008). Neural tube defects account for 3,000 birth defects each year in the United States, and the two most common defects are spina bifida and anencephaly (CDC, 2008). Spina bifida occurs when the fetal spinal column does not close completely during development, often causing nerve damage possibly resulting in partial paralysis (NIH & NLM, 2009). Anencephaly occurs when a portion of the brain does not develop, generally leading to stillbirth or death shortly after birth (NIH & NLM, 2009). These defects take an emotional and monetary toll on families, with lifetime costs ranging from $636,000 to $1 million (CDC, 2008). Folic acid also reduces the risk of other congenital anomalies, such as defects of the urinary tract, cardiovascular defects, and orofacial clefts (Czeizel, Dobo, & Vargha, 2004). The benefits of folic acid in the reduction of neural tube defects and other birth defects have been well documented.

Weight management. Maternal weight gain is a vital part of prenatal health, and the ACOG and the IOM provide guidelines to determine appropriate amounts of maternal weight gain based upon maternal prepregnancy weight, or that less total weight gain during pregnancy is recommended with higher prepregnancy weight and vice versa (Table 2) (ACOG, 2009; IOM, 2009). Preconception health, on the other hand, focuses only on prepregnancy weight.

It is especially important to achieve and maintain a healthy weight prior to pregnancy, because dieting can be harmful during pregnancy (DHHS, 2009b). The breakdown of fat during dieting yields byproducts known as ketones, which are toxic to a fetus and may impair mental and physical development (DHHS, 2009b). The ACOG, MOD, AAFP, the National Institutes of Health (NIH), and the World Health Organization (WHO), state that individuals should be encouraged to maintain or work towards a

healthy body mass index (AAFP, 2009; ACOG, 2009; Massiah & Kumar, 2008; MOD, 2005). Body mass index (BMI) is a measure of weight relative to height, and it is a reliable indicator of total body fat (National Heart Lung and Blood Institute [NHLBI], 2008). BMI is calculated as weight in kilograms divided by height in meters squared. The resulting BMI number is then ranked on a scale: underweight is below 18.5 BMI, normal weight is 18.5 to 24.9 BMI, overweight is 25-29.9 BMI, and obese is 30 BMI and above (Table 2).

Table 2. Institute of Medicine recommendations for maternal weight gain.

Prepregnancy BMI	**BMI (kg/m^2)**	**Total Weight Gain Range (lbs) (singleton pregnancy)**	**Rates of Weight Gain 2nd and 3rd Trimester (mean range in lbs/week)**
Underweight	<18.5	28 – 40	1 (1–1.3)
Normal weight	18.5 – 24.9	25 – 35	1 (0.8–1)
Overweight	25.0 – 29.9	15 – 25	0.6 (0.5-0.7)
Obese (includes all classes)	≥30.0	11 – 20	0.5 (0.4-0.6)
(Institute of Medicine, 2009)			

The BMI has certain limitations. It is not a measure of body composition (AAFP, 2000). There is a strong correlation between BMI score and body fatness, but the correlation varies by sex and age (National Heart, Lung, and Blood Institute [NHLBI], 2008). For example, at the same BMI, women tend to have more body fat than men; at the same BMI, older adults tend to have more body fat than younger adults; and, athletes tend to have a higher BMI due to increased muscularity rather than increased

body fatness (NHLBI, 2008). However, this study is comparing only the BMIs of women between 18 and 44 years of age, and according to the IOM, the BMI is the best available measure of prepregnancy weight (IOM, 2009).

Obesity prior to pregnancy is a serious health concern. Overweight individuals with a BMI 25.0 to 29.9 have a mildly increased risk of comorbidity, and obese individuals with a BMI of 30.0 to 34.9 (Class I), a BMI of 35.0 to 39.9 (Class II), and a BMI of 40 or more (Class III) have moderate, severe, and very severe risks of comorbidity respectively (AAFP, 2000). In 2003, 19.6% of women in the United States between 18 and 44 years of age were obese (MOD, 2005). In 2009, the IOM reported that eight percent of U.S. women of reproductive age were severely obese (AAFP, 2009).

Maternal health consequences of prepregnancy maternal obesity are numerous. Prior to conception, there is a higher prevalence of polycystic ovary syndrome among obese women, an endocrine condition characterized by amenorrhea (absence of menstruation) and infertility (Ehrmann, 2005). Maternal obesity is also associated with a 25-37% higher risk of miscarriage compared to non-obese women (Hamilton-Fairley, et al., 1992). Once pregnant, certain maternal complications are more prevalent among obese women (Guelinckx, Devlieger, Beckers, & Vansant, 2008; Weiss, et al., 2004). Maternal obesity increases the risk of gestational diabetes, which is associated with an increased risk of fetal macrosomia (when the fetus is large [over the 90th percentile] for gestational age) and an increased risk of the development of diabetes later in life (Rudra, et al., 2007; Rode, Nilas, Wojdemann, & Tabor, 2005; Ehrenberg, Mercer, & Catalano, 2004; Sebire, et al., 2001). Typically, 30% of women are at risk of developing diabetes within 15 years of delivery, but this risk increases to 70% among obese women (O'Sullivan, 1984). Maternal obesity also increases the risk for pregnancy-induced hypertension and preeclampsia, conditions characterized by high blood pressure

(Doherty, 2006; Leeners, 2006; Rode, Nilas, Wojdemann, & Tabor, 2005). Frederick and colleagues determined that for every unit increase in prepregnancy BMI, there is a resulting eight percent increase in the risk of preeclampsia (Frederick, et al., 2006). Another study determined that there were significant decreases in preeclampsia risk associated with BMI decreases (Villamor & Cnattingius, 2006). Maternal obesity is also associated with deep venous thrombosis, in which blood clots can block blood flow, and pulmonary embolism, in which a clot travels to the blood supply of the lungs, possibly resulting in death (Sebire, et al., 2001). Obese women are at higher risk of venous thromboembolism (adjusted OR 5.3 [95% CI 2.1, 13.5]) compared with normal weight women before and after birth (Larsen, Sorensen, Gislum, & Johnsen, 2007). Research presents conflicting findings in relation to the association between maternal obesity and preterm delivery. Varying studies find a decreased risk (Sebire, 2001; Cnattingius, Bergstrom, Lipworth, Kramer, 1998), an increased risk (Baeten, Bukusi, & Lambe, 2001), or even no difference in preterm delivery when obese women are compared with women with a normal BMI (Jensen, et al., 2003; Galtier-Dereure, Boegner, & Bringer, 2000). With increasing prepregnancy BMI, there is an increased risk of caesarean section, either elective or unplanned (Barau, et al., 2006; Graves, DeJoy, Heath, & Pekow, 2006). When obese women undergo delivery via caesarean section, there is increased risk for anesthetic complications (Saravanakumar, Rao, & Cooper, 2006), excessive bleeding, and post-partum infections (Sebire, 2001), which results in increased hospitalization, increased cost, and increased risk for deep vein thrombosis due to prolonged immobilization (Callaway, Prins, Chang, & McIntyre, 2006; Sebire, 2001; Galtier-Dereure, Boegner, & Bringer, 2000). Following delivery, certain maternal complications are more prevalent among overweight and obese women, such as hemorrhage, anemia, genital and urinary tract infections, endometritis, stress

incontinence, and depression (Lacoursiere, Baksh, Bloebaum, & Varner, 2006; Bodnar, Siega-Riz, & Cogswell, 2004; Sebire, 2001; Galtier-Dereure, Boegner, & Bringer, 2000). Fetal health consequences of prepregnancy maternal obesity are also multitudinous. Maternal obesity is more than twice as likely to result in a stillbirth or perinatal death when compared to women of normal weight (Kristensen, et al., 2005). Macrosomia, defined previously with maternal complications, may lead to birth traumas, such as shoulder dystocia and possible brachial plexus injury (Dyachenko, 2006). Maternal obesity is also associated with fetal birth defects, such as neural tube defects, abdominal wall defects, heart defects, and multiple congenital anomaly syndromes (Watkins, et al., 2003). Maternal obesity and gestational diabetes act synergistically to increase the risk of congenital defects (Moore, et al., 2000). Due to these fetal complications, the percentage of infants admitted to intensive care is 3.5 times greater among infants born to obese women compared to infants born to women of normal weight (Galtier-Dereure, Boegner, & Bringer, 2000).

Research often overlooks the other prepregnancy weight extreme, the underweight category. This lack of emphasis may be due to its prevalence. Whereas eight percent of women of reproductive age in the United States are severely obese, only three percent are underweight (less than 18.5 BMI) (AAFP, 2009). Underweight class, in the empirical research, varies from the Institute of Medicine's classification of less than 18.5 BMI (IOM, 2009) to a BMI of 19.8 kg/m^s or less among other studies (Ehrenberg, Dierker, Milluzzi, & Mercer, 2003; Schieve, et al., 2000). According to Ehrenberg and colleagues, among 15,196 subjects, the 13.2% of participants with BMI less than or equal to 19.8 kg/m^s were at increased risk for maternal and fetal complications (2003). In this study, underweight status was associated with preterm labor (RR 1.22; 95% CI 1.02, 1.46), intrauterine growth restriction (RR 1.67; 95% CI 1.2, 2.39), and low birth weight (RR1.13; 95% CI 1.0, 1.27), and it was protective against

caesarean delivery (RR 0.8; 95% CI 0.71, 0.91) (Ehrenberg, Dierker, Milluzzi, & Mercer, 2003). These perinatal conditions may have serious consequences for the fetus as discussed previously. In overweight and obese women, weight loss prior to pregnancy reduces perinatal risks, and vice versa for underweight women (Kramer, 2000; Nawaz & Katz, 2001).

Smoking cessation. Among smokers, tobacco use is the leading cause of illness and death in the United States with 440,000 deaths per year (CDC, 2005b). Even though smoking is the most preventable cause of all early death in the United States, women continue to use tobacco (American Cancer Society [ACS], 2007). About 18% of women aged 18 years and older smoke cigarettes (ACS, 2007). In the U.S. annually, almost 500,000 infants are born to the 11.4% of women who report smoking during pregnancy (CDC, 2004; Martin, et al., 2003).

Numerous health risks related to pregnancy are associated with tobacco use. Tobacco use is associated with male impotence, conception delay, and infertility prior to conception (Rosenthal, Melvin, & Barker, 2006). Complications during pregnancy associated with tobacco use include increased risk for spontaneous abortion, ectopic pregnancy, low birth weight, sudden infant death syndrome (SIDS), and premature birth (DHHS, 2001). Maternal complications may also include increased risk of premature rupture of the membranes, placental abruption, and placenta previa (CDC, 2007). Even environmental tobacco smoke, such as secondhand smoke, may increase fetal health risks, such as increased risk for low birth weight and intrauterine growth restriction compared to fetuses without environmental tobacco smoke exposure (DHHS, 2001). Smoking cessation is a difficult journey for most smokers. About 70% of smokers are reported to want to quit smoking, and about 40% of those quit for at least one day every year (CDC, 2003). Pregnancy increases the likelihood that women will stop smoking compared to other times (DHHS, 2001). However, only 20% of women successfully quit

smoking during pregnancy (Hopkins, et al., 2001), and most women relapse within one year of giving birth (Carmichael & Abluwalia, 2000; Mullen, Richardson, Quinn, & Ershoff, 1997; Pollak & Mullen, 1997; McBride, Pirie, & Curry, 1992; O'Campo, Faden, Brown, & Gielen, 1992; Fingerhut, Kleinman, & Kendrick, 1990; McBride & Pirie, 1990). Further research is required to assess the determinants of perinatal smoking (Kahn, Certain, & Whitaker, 2002).

Avoidance of alcohol. Human and animal studies have not demonstrated a safe threshold for alcohol consumption during pregnancy (Sood, et al., 2001; Shaw & Lammer, 1997; Lundsberg, Bracken, & Saftlas, 1997; Jacobson & Jacobson, 1994). Yet, in 2002, 54.9% of women of reproductive age and 10.1% of pregnant women admit to drinking alcohol (Tsai & Floyd, 2004). Of these women, 12.5% of women of reproductive age and 1.9% of binge drinkers report binge drinking, which seems to be more detrimental to a developing fetus than low-level daily drinking (Tsai & Floyd, 2004; Maier & West, 2001; Stratton, Howe, & Battaglia, 1996). The placental membrane separating the fetal and maternal circulatory systems is easily penetrated by alcohol, and thus, the blood alcohol of the fetus is typically consistent with maternal blood alcohol level (Little, & Vanbeveren, 1996; Stratton, Howe, & Battaglia, 1996).

In the United States, about 1% to 3% of all live births are affected by fetal alcohol exposure (Mengel, Searight, & Cook, 2006). Fetal exposure to alcohol may result in a range of complications and birth defects, also known as fetal alcohol spectrum disorders, (FASD) which negatively impact child development, cognition, physical appearance, and behavior throughout life (CDC, 2004; Sokol, Delaney-Black, & Nordstrom, 2003; Stratton, Howe, & Battaglia, 1996; Jones & Smith, 1973).

The most serious disorder in this spectrum, fetal alcohol syndrome (FAS), is the leading preventable cause of mental retardation in the United States (Stratton, Howe, & Battaglia, 1996; Streissguth, 1994). FAS typically occurs among children of women who

use alcohol heavily on a chronic basis (Abel, 1990), but further research demonstrates the adverse FAS outcomes among children of women who use low-level alcohol, with as few as four drinks per week (Moore, Khoury, & Liu, 1997; Windham, et al., 1997). FAS is characterized by physical and mental disabilities, abnormal facial features, growth deficiencies, and central nervous system problems (CDC, 2006d).

Another disorder, alcohol-related neurobehavioral disorder (ARND), impacts neurobehavioral effects and the central nervous system without displaying FAS characteristics (Mattson, et al., 1997). With ARND, abnormalities include small head circumference (10% or less), learning disabilities, poor impulse control, seizures, deficits in language and math skills, and problems with memory, attention, and judgment (Mengel, Searight, & Cook, 2006; Mattson, et al., 1997). Another set of outcomes may be classified as alcohol-related birth defects (ARBD), which is characterized by FAS features, low set ears, micrognathia (undersized jaw), epicanthal folds (skin folds of the upper eyelid), low nasal bridge, short upturned nose, strabismus (lack of eye coordination), clinodactyly (curvature of the fifth finger), “hockey stick” palmar crease (single crease in hand as opposed to two), radioulnar synostosis (fusion of the two forearm bones), renal anomalies (problems with kidneys), and cardiac defects (Mengel, Searight, & Cook, 2006). Together, ARND and ARBD are four times more common than FAS (Hoyme, et al., 2005; May, et al., 2004; May & Gossage, 2001; Stratton, Howe, & Battaglia, 1996).

Even though many organ systems may be affected by alcohol exposure in the fetus, the brain is especially sensitive (Riley, McGee, & Sowell, 2004; Mattson & Riley, 1996; Clarren, 1986). Complications of the fetal brain related to alcohol exposure include microcephaly (abnormal smallness of the head); migration anomalies (abnormality when neuronal cells migrate prior to differentiation); agenesis (failure to form) or thinning of the corpus callosum and anterior commissures; cerebellar,

brainstem, and basal ganglia anomalies; and neuroglial heterotopias (rare congenital cell masses of the brain) (Riley, McGee, & Sowell, 2004; Mattson & Riley, 1996; Clarren, 1986). Even low levels of alcohol may compromise normal fetal brain structure and function, resulting in impaired neurogenesis, cell proliferation, and cell migration (Mattson & Riley, 1996; Clarren, 1986). These complications impact cellular connectivity, synaptosis (degeneration of cell synapses, or areas of communication), maturation, and apoptosis (programmed cell death), which are vital to healthy cellular life (Mattson & Riley, 1996; Clarren, 1986). Conditions and complications resulting from fetal alcohol exposure are completely preventable if a woman abstains from alcohol consumption from the time of offspring conception through birth (Whitlock, Polen, Green, Orleans, & Klein, 2004).

Avoidance of narcotics, amphetamines, and marijuana. Among pregnant women, nearly four percent use narcotics, amphetamines, or marijuana at some time during gestation (Substance Abuse and Mental Health Administration, 2006). Drug effects on the fetus vary based upon how much drug was taken, how often, and the period during pregnancy in which it was used (ACOG, 2009c). Different drugs taken together may act synergistically, and some drugs may be processed with impure substances that are harmful to a fetus (MOD, 2006). The following drugs and their perinatal effects will be briefly discussed in this review: cocaine, heroin, amphetamines, and marijuana. Other drugs also may cause harmful perinatal effects, but the empirical literature is lacking in these areas. Also, it is difficult to measure the impact of these types of drugs on the fetus, because detrimental effects from alcohol use, smoking, and poor nutrition often accompany drug use (MOD, 2006).

Cocaine is a vasoconstrictive substance, and when crossing the placental barrier, it restricts the necessary blood flow needed for healthy fetal development (Behnke, Eyler, Garvan, & Wobie, 2001). Cocaine use increases the risk of miscarriage

in early pregnancy, and later fetal complications include increased risk for preterm labor, low birth weight, small head circumference, smaller than normal brain size, birth defects, and stroke (Bauer, et al., 2005; Vidaeff & Mastrobattista, 2003; Bateman & Chiriboga, 2000). Maternal complications associated with cocaine use include placental complications, such as placental abruption, in which the placental lining separates from the uterus (MOD, 2006). Those infants exposed to cocaine in utero may experience mild behavioral disturbances, such as sensitivity to touch, irritability, or withdrawal from surrounding stimuli (Bauer, et al., 2005).

Perinatal complications associated with heroin use include premature rupture of the membranes (amniotic sac breaks too early leading to possible infection), preterm delivery, stillbirth, low birth weight, and birth defects (Briggs, Freeman & Yaffe, 2005). Fetal exposure to heroin often lead to withdrawal symptoms in infancy, such as fever, sneezing, trembling, irritability, diarrhea, vomiting, continual crying, and sometimes seizures (Briggs, Freeman, & Yaffe, 2005).

The fetal effects resulting from amphetamine use, including ecstasy and methamphetamines, are not well studied. However, amphetamines have been associated with congenital heart defects, skeletal defects like clubfoot, other birth defects, low birth weight, small head circumference, preterm delivery, and placental complications (Smith, et al., 2006).

Marijuana, also known as cannabis, derives from the hemp plant, and it may contain up to 400 different chemicals (Organization of Teratology Information Specialists [OTIS], 2007). Marijuana is the most prevalent illicit drug consumed among women of reproductive age, and estimates for marijuana use are almost three percent among pregnant women (Ebrahim & Gfroerer, 2003). Marijuana use prior to pregnancy can hinder fertility in men and women and lower male sperm counts (MOD, 2006). Among pregnant women using marijuana on a regular basis (six or more time per week), there is

a slightly increased risk of preterm delivery (OTIS, 2007). A study involving 1,690 mother/child pairs determined that there was statistically significant association between marijuana use during pregnancy and low birth weight, and users of marijuana were five times more likely than non-users to deliver infants with features similar to fetal alcohol syndrome (Lynn, et al., 1983; Hingson, et al., 1982). Since the beginning of the 21st century, marijuana's active ingredient, ∆-9-tetrahydrocannabinol (THC), has strongly increased in concentration, which may induce stronger fetal effects in the future (Pijlman, et al., 2005).

Oral health care. Oral health is an important and often overlooked part of preconception and prenatal care. In the United States, however, only 22% to 34% of women preventively visited the dentist during pregnancy, and when a dental problem occurred, only half of all pregnant women sought dental care (Gaffield, Gilbert, Malvitz, & Romaguera, 2001). There are currently no national guidelines for dealing with oral conditions during pregnancy (Silk, Douglass, Douglass, & Silk, 2008), and therefore, there is fear among the dental community of medicolegal action based on negligent or substandard treatment of oral conditions during pregnancy (Stefanac, 2001). The American Dental Association (ADA) recommends, however, that pregnant women avoid elective dental care, if possible, during the first trimester and during the last one-half of the third trimester (ADA, 1995). This narrow window of potential dental care is possibly recommended in part because of increased teratogenic risk, risk of spontaneous abortion in the first trimester, and an attempt to avoid causal association with dental procedures in either case (Pertl, et al., 2000; Sabatka, Bhattacharyya, Cohen, & Hunter, 2000; Lee, McWilliams, & Janchar, 1999; Wasylko, et al., 1998). The third trimester end of the narrow window for dental care is recommended because of the association between increased fetal sensitivity to external stimuli and increased risk of premature delivery (Lee, McWilliams, & Janchar, 1999; ADA, 1995).

Maternal dental complications increase during the pregnancy period. With varying levels of morning sickness, gastric acid may lead to tooth enamel erosion (ADA Council on Access, Prevention, and Interprofessional Relations, 2006). This increased acidity, in combination with sugary dietary cravings, and lack of regular dental care increases the risk of tooth decay in pregnant women (Hey-Hadavi, 2002). Gingival changes during pregnancy have been well documented (Mealey, 1996). Increased progesterone due to pregnancy may induce temporary oral tumors (pyogenic granulomas) or loose teeth among pregnant women (Silk, Douglas, Douglas, & Silk, 2008). Pregnancy hormone fluctuations combined with changes to the oral flora and decreased immune response lead to the most common oral disease of pregnancy, gingivitis, which occurs among 60 to 75% of pregnant women (Silk, Douglas, Douglas, & Silk, 2008; ADA Council on Access, Prevention, and Interprofessional Relations, 2006). In preconception terms, about 30% of women of reproductive age experience periodontitis, a destructive bacterial inflammation of the periodontum akin to gingivitis (Kumar & Samelson, 2006).

The association between periodontitis and poor pregnancy outcomes is well documented (Silk, Douglas, Douglas, & Silk, 2008). The causal mechanism is unclear for the periodontal relationship, but studies demonstrate that certain periodontopathic bacteria in pregnant women can cross the placental barrier (León, et al., 2007). Such mirobacterial invasion of *P. gingivalis, T. forsythensis,* and *E. corrodens,* resulting from periodontal disease, has been associated with preeclampsia among pregnant women (Contreras, et al., 2006). In a systematic review of empirical studies across 12 countries and involving approximately 15,000 women, 24 studies were identified as demonstrating a positive relationship between periodontitis and preterm birth, low birth weight, or both (Clothier, Stringer, & Jeffcoat, 2007). Fourteen studies demonstrated no relationship between periodontitis and poor pregnancy outcomes (Clothier, Stringer, & Jeffcoat,

2007). Another recent large randomized controlled trial conducted in the United States reported no association between periodontitis and preterm birth and low birth weight (Michalowicz, et al., 2006). Treatment of periodontal disease in pregnant women during pregnancy improved oral disease outcomes, but it did not significantly change the prevalence of preterm birth, low birth weight, or fetal growth restriction (Michalowicz, et al., 2006). Proper oral hygiene and routine periodontal care prior to pregnancy is recommended (American Academy of Periodontology, 2004).

Medical health care. About 84% of women in the United States ages 18 to 44 visited a medical provider in 2004, and 55% obtained preventive health services (Salganicoff, Ranji, & Wyn, 2005). Thus, physicians, obstetrician/gynecologists and general practitioners alike, are poised to deliver effective preconception care and health education to the majority of women in the U.S. According to one study of obstetrician-gynecologists' opinions, 87% of physicians thought preconception care was important, and 94% recommended such care to patients planning a pregnancy (Morgan, Hawks, Zinberg, & Schulkin, 2006). However, nearly half (49%) of physicians said very few patients came in for preconception care (Morgan, Hawks, Zinberg, & Schulkin, 2006). Even though Frey and Files demonstrated that 95% of women surveyed prefer to obtain preconception care information from their primary care providers, only 39% recalled their physician ever discussing the topic (Frey & Files, 2006). Physician participation is essential for the screening of some key preconception health components: medication consultation (prescription and over-the-counter), screening and consultation for medical conditions [diabetes, epilepsy, hypertension, asthma, thyroid disorders, maternal phenylketonuria (PKU)], sexually transmitted infection (STI) testing, family history analysis, and immunizations. Addressing preconception health components at a physician visit is important. In addition, subcomponents of a preconception physician visit will be further discussed here, due to the individual preconception behaviors

required for disease management that a woman must perform, such as diabetes or hypertension management. These subcomponents are initially recognized through screenings at the physician visit, but they are then maintained by ongoing individual behaviors.

Certain medical conditions may have adverse pregnancy outcomes, such as diabetes, epilepsy, hypertension, asthma, thyroid disorders, and maternal PKU. These conditions, if not monitored appropriately during pregnancy, may lead to fetal and maternal complications.

Diabetes mellitus, a metabolic condition characterized by abnormally high blood glucose levels, is defined as poorly controlled when glycosylated hemoglobin levels are higher than 8.4 percent (Brundage, 2002). Uncontrolled diabetes mellitus may substantially increase the risk of birth defects (seven times that of women with controlled diabetes), miscarriage (32% increased risk), stillbirth, pre-eclampsia, preterm delivery, and large for gestation age fetuses compared to women with good control of their diabetes (Organization of Teratology Information Specialists [OTIS], 2008a; Brundage, 2002). Proper management of diabetes, whether type 1 or 2, through the monitoring of blood glucose levels substantially reduces these risks (Kitzmiller, Buchanan, Kjos, Combs, & Ratner, 1996; American Diabetes Association, 2004).

Epilepsy, a chronic neurological disorder characterized by recurrent seizures, is associated with four to eight percent of birth defects (ACOG, 1997). Women with epilepsy are also at increased risk for vaginal bleeding, placental abruption (premature separation of the placenta), preeclampsia, and premature birth. Medications to treat epilepsy are associated with birth defects, but without such medication, seizures may pose other health risks for the fetus, like oxygen deprivation (Mayo Clinic, 2007). As multiple anticonvulsants are to be avoided and no single drug of choice, the American

Academy of Family Physicians recommends the use of a single agent administered for the seizure type at the lowest protective level (Brundage, 2002).

Chronic hypertension, defined as high blood pressure diagnosed prior to pregnancy or before 20 weeks' gestation, occurs in one to five percent of all pregnancies (Agency for Healthcare Research and Quality [AHRQ], 2000). This medical condition is most often associated with an uncomplicated pregnancy, but monitoring is necessary for the risks of preeclampsia, renal insufficiency, and intrauterine growth restriction (Brundage, 2002). Certain hypertension medications, like angiotensin-converting enzyme inhibitors, angiotensin II receptor antagonists, and thiazide diuretics, are associated with an increased risk of birth defects (Brundage, 2002). However, other drugs, like methyldopa and calcium channel blockers, are commonly used during pregnancy without such risk (Brundage, 2002).

Asthma, a chronic disorder of the airways characterized by recurrent airflow obstruction, bronchial hyperresponsiveness, and inflammation, occurs in about eight percent of all pregnancies (Kwon, Triche, Belanger, & Bracken, 2006). Asthma is associated with increased risks of preeclampsia, preterm birth, low birth weight, intrauterine growth restriction, birth defects, and perinatal death compared with women without a history of asthma (Schatz & Dombrowski, 2009). With no clear understanding as to the underlying causal mechanisms, pregnancy may improve, worsen, or not affect maternal asthma (Schatz & Dombrowski, 2009). The use of inhaled [beta]-agonists or inhaled corticosteroids has not been associated with perinatal risks (Martel, et al., 2007; Bakhireva, et al., 2005; Schatz, 2004).

The thyroid is a part of the endocrine system, and thyroid disorders are characterized by reduced hormone production, hypothyroidism, or increased hormone production, hyperthyroidism (March of Dimes, 2009e). Untreated hyperthyroidism has been associated with increase risk for fetal tachycardia (fast heart rate), small for

gestational age infants, premature birth, stillbirth, and birth defects (American Thyroid Association [ATA], 2005). Graves' disease causes 80-85% of maternal hyperthyroidism during pregnancy (ATA, 2005). Treating maternal hyperthyroidism typically results in a healthy pregnancy, and usually anti-thyroid drug therapy, like methimazole or propylthiouracil (PTU), is administered (ATA, 2005). Untreated hypothyroidism has been associated with increased risk of maternal anemia (low red blood cell count), myopathy (muscle pain and weakness), congestive heart failure, preeclampsia, placental abnormalities, low birth weight infants, postpartum hemorrhage (bleeding) (ATA, 2005). Levothyroxine medication, a synthetic thyroid hormone used to treat hypothyroidism, must be increased in early pregnancy for proper neurologic development of the fetus (American Association of Clinical Endocrinologists, 2002; ACOG, 2002).

Maternal phenylketonuria (PKU), an autosomal recessive genetic disorder characterized by an enzyme deficiency, affects one in 25,000 babies (March of Dimes, 2009f). Untreated maternal PKU may increase the risk of low birth weight, mental retardation, heart defects, behavior problems, and characteristic facial features in infants (OTIS, 2008b). Women may avoid these adverse pregnancy outcomes by adhering to a low phenylalanine diet prior to and during pregnancy (ACOG, 2002). All babies born in the United States are tested with a heel-stick for elevated levels of PKU in the blood, and preventive measures are then taken to reduce the effects associated with uncontrolled PKU (MOD, 2009f).

Prescription and over-the-counter drugs potentially affect fetal development, and it is important for women to discuss their medications with their physician or pharmacist. About 82% of women of reproductive age use some type of medication, and about 46% of these women use a prescription medication (Kaufman, Kelly, Rosenberg, et al., 2002). Certain drugs have been shown to be problematic for pregnancy, and three to six percent of birth defects may be attributed to drug or chemical exposure (Brundage,

2002). Isotretinoins used to treat acne, may result in miscarriage and birth defects when taken during pregnancy (Perlman, Leach, Dominguez, Ruszkowski, & Rudy, 2001; Perlman, Rudy, Pinto, & Townsend-Akpan, 2001). Anti-epileptic drugs, like valproic acid, are known to be teratogenic, and should be provided in lower doses to women of reproductive age (Morrell, 1998; Crawford, Appleton, Betts, Duncan, Guthrie, & Morrow; 1999; Barrett & Richens, 2003). Warfarin, an oral anticoagulant, is also a known teratogen, and non-teratogenic anticoagulants should be prescribed to women of reproductive age with certain blood disorders (Ressell, 2001; Hirsh, Fuster, Ansell, & Halperin, 2003). Fetal defects resulting from a drug or chemical exposure vary depending with the time of exposure (Brundage, 2002). Fetal exposure before day 17 of development may be lethal, as in exposure to anticancer drugs that inhibit cellular replication (Vallance, 1996). Exposure between days 17 and 56 affects organogenesis, as in exposure to vitamin A drugs, like retinoids, that may cause structural anomalies (Cefalo & Moos, 1995) or physical and mental defects (Mitchell, Van Bennekom, & Louik, 1995). Exposure after day 56 may cause a functional impairment (Cefalo & Moos, 1995), a general retardation of growth as in the use of beta blockers (Vallance, 1996), or organ system maturation defects, as in the association between angiotensin-converting enzyme inhibitors and abnormalities of renal function and skull development (Brent & Beckman, 1991). One study demonstrated a lack of information regarding the risk and safety of more than 90% of medications, approved by the Food and Drug Administration between 1980 and 2000, when taken during pregnancy (Lo & Friedman, 2002). In addition, teratogenicity is unclear for many prescription and over-the-counter drugs, but at least these substances are subject to federal regulation and testing procedures. Whereas dietary supplements, including herbal supplements, are not subject to strict regulation and also may be teratogenic (National Center for Complementary and Alternative Medicine, 2009). Further research and testing is

needed to clearly determine the safety of many prescription drugs, over-the-counter drugs, and herbal supplements.

Many sexually transmitted infections (STI) are associated with adverse pregnancy outcomes (Majeroni & Ukkadam, 2007). In the United States each year, pregnant women are infected with the following STIs: 1,080,000 cases of bacterial vaginosis, 880,000 cases of genital herpes, 100,000 cases of chlamydia, 124,000 cases of trichomoniasis, 13,200 cases of gonorrhea, 16,000 cases of hepatitis B, and 6,400 cases of HIV (CDC, 2008b). Also, about 26.8% of women between 14 and 59 years of age are infected with human papillomavirus (HPV) (Dunne, et al., 2007).

STI screening recommendations vary for nonpregnant and pregnant women. The U.S. Preventive Services Task Force, the CDC, the AAFP, and the ACOG do not recommend routine STI screening for nonpregnant women not at increased risk for STIs (Meyers, et al., 2008). Increased risk of STI transmission is determined by high-risk sexual behavior (e.g., having multiple current partners, having new partners, using condoms inconsistently) and age (U.S. Preventive Services Task Force, 2007, 2005a, 2005b; Calonge, 2004). Women under the age of 25, are at increased risk of STI transmission due to increased sexual risk taking, immature immune systems, and the presence of columnar epithelium on the adolescent cervix (U.S. Preventive Services Task Force, 2007, 2005a, 2005b; Calonge, 2004). The aforementioned agencies recommend that nonpregnant women at increased risk for contracting STIs should be screened for syphilis, human immunodeficiency virus (HIV), chlamydia, and gonorrhea (Meyers, et al., 2008). These agencies also recommend STI screening for hepatitis B, HIV, and syphilis for all pregnant women, and additional screening for chlamydia and gonorrhea for pregnant women at increased risk for STIs (Meyers, et al., 2008). Recommendations for pregnant or nonpregnant women for other STIs, such as hepatitis C, herpes simplex virus (HSV), human papillomavirus (HPV), and are excluded as either a

recommendation not to screen or a statement citing lack of specific recommendation (Meyers, et al., 2008).

Sexually transmitted infections can be passed from mother to fetus or infant before, during, or after the baby's birth. Some STIs (e.g., syphilis) infect the fetus in utero via the placenta (CDC, 2008b). Other STIs (e.g., gonorrhea, chlamydia, hepatitis B, HPV, and genital herpes) infect the infant during the birthing process as the baby is pushed through the birth canal (CDC, 2008b). Cesarean deliveries may reduce this risk (ACOG, 2009d). HIV can infect the fetus or infant by crossing the placenta, during delivery through the birth canal, and after birth during breastfeeding (CDC, 2008b). Untreated sexually transmitted infections during pregnancy may lead to fetal and maternal complications. About five to fifteen percent of pregnant women are infected with *Chlamydia trachomatis*, or Chlamydia, which may result in fetal opthalmia neonatorum (bacterial conjunctivitis or eye infection), pneumonitis (inflammation of lung tissue), low birth weight, or preterm birth or maternal postpartum endometritis (infection of the lining of the uterus) (Andrews, et al., 2006). The risk of perinatal transmission of *Neisseria gonorrhea,* or gonorrhea, is between 30% and 47%, which may result in opthalmia neonatorum, systemic neonatal infection, maternal endometritis, or pelvic infection (Brocklehurst, 2002). *Treponema pallidum,* or syphilis, is highly transmissible with or without symptoms, and this infection is associated with hydroamnios (excessive amniotic fluid), spontaneous abortion, preterm delivery, fetal hydrops (abnormal accumulation of fluid), prematurity, fetal distress, stillbirth, congenital syphilis, and neonatal death (Apea-Kubi, et al., 2004; Wendel, et al., 2002). *Trichomonas vaginalis,* or trichomoniasis, is a sexually transmitted vaginal infection that is associated with preterm delivery and low birth weight (Riggs & Klebanoff, 2004). Bacterial vaginosis, a sexually related infection, may result in preterm birth, premature rupture of the membranes, and low birthweight (Majeroni & Ukkadam, 2007). These five STIs and

sexually related infections may be treated and cured with antibiotics, even during pregnancy (CDC, 2008b). Hepatitis B may be transmitted from mother to child, and it may lead to hepatic failure, liver carcinoma, cirrhosis, and even death (Arevalo, 1989). Routine screening for hepatitis B is recommended for all pregnant women, because immunoprophylaxis with hepatitis B vaccine and hepatitis immune globulin may be administered perinatally to reduce the probability of viral infection in exposed infants (Arevalo, 1989). Human papillomavirus (HPV), a virus that may result in genital warts or cervical cancer, may resolve spontaneously (Majeroni & Ukkadam, 2007). Perinatal transmission, though rare, may occur, possibly resulting in warts on the infant's throat or voice box (U.S. DHHS, 2009). Genital warts may be removed prior to pregnancy with medication or surgical removal (Majeroni & Ukkadam, 2007). Trichloroacetic acid, 80-90%, may be applied by a health care professional weekly to remove warts safely during pregnancy (Majeroni & Ukkadam, 2007). Herpes simplex virus (HSV), a common viral STI, affects about one in four births (ACOG, 2007b), and third trimester maternal infection increases the risk of perinatal transmission between 30% and 50% (Majeroni & Ukkadam, 2007). Herpes infections in newborns may affect the skin, mouth, eyes, brain, and internal organs, which may lead to mental retardation, cerebral palsy, seizures, and vision or hearing loss (ACOG, 2007b). Antiviral medication reduces the rate of perinatal transmission significantly (Andrews, et al., 2006; Sheffield, et al., 2003; Watts, et al., 2003). Human immunodeficiency virus (HIV), a virus that may lead to acquired immune deficiency syndrome (AIDS), compromises the immune system allowing for opportunistic infection (ACOG, 2009d). Without treatment, HIV perinatal transmission may occur in one of every four babies born to an HIV-infected mother (ACOG, 2009d). However, with antiviral treatment and cesarean delivery, perinatal transmission of from infected mothers may be reduced by 99% (ACOG, 2009d).

Vaccinations are an important part of primary prevention in the protection of maternal and fetal health. Immunizations administered prior to pregnancy are optimal to prevent disease to potential offspring, but some vaccines may be administered during pregnancy (ACOG, 2003). A concern of vaccination during pregnancy is the primarily theoretical risk of transmitting the virus to the developing fetus (AAFP, 2003). Thus, live-virus vaccines are contraindicated for pregnant women, such as LAIV influenza, measles, mumps, rubella, and varicella vaccines (CDC, 2007d). At this time, there is no evidence of increased risk to the fetus when vaccinating pregnant women with inactivated virus (e.g., hepatitis A, inactivated influenza), bacterial vaccines (e.g., pertussis), or toxoids (e.g., tetanus and diphtheria) (CDC, 2007d). Even in these instances, physicians may adhere to certain vaccination regimens based upon the gestational age of the fetus (AAFP, 2003). To ensure maximal vaccination effectiveness without harm to potential offspring, preconceptional vaccination is key (ACOG, 2003). Immunization against hepatitis B, rubella (German measles), varicella, Tdap (tetanus, diphtheria, and pertussis), HPV, and influenza vaccines are recommended among women of reproductive age (Lu, 2007). Preconceptional hepatitis B vaccination is recommended. Hepatitis B, previously discussed and primarily considered a sexually transmitted infection, may also be transmitted via blood transfusions, infected wounds, or infected needles (Coonrod, et al., 2008). Perinatal transmission associated with acute maternal hepatitis B infection ranges from 10% during the first trimester to 90% during the third trimester (ACOG, 1998). And, hepatitis B infection in utero has an increased risk of low birthweight and prematurity (Shepard, 1998; Hieber, Dalton, Shorey, & Combes, 1977). For those infants perinatally exposed to hepatitis B infection, immune globulin should be administered within 12 hours of delivery, followed by vaccinations at birth, one, and six months (Coonrod, et al., 2008). This procedure offers 95% protective efficacy against hepatitis B infection; however, these costly procedures are extraneous if

a woman receives preconceptional vaccination against hepatitis B and avoids infection altogether (Coonrod, et al., 2008). Rubella and varicella vaccines involve live-attenuated viruses, and therefore, are contraindicated for administration during pregnancy (CDC, 2007d). Therefore, preconceptional administration of these vaccines is essential (Lu, 2007). The rubella immunization is typically administered as part of the trivalent MMR vaccine – measles, mumps, and rubella. This vaccine provides protective seronegativity for the mother, and it prevents congenital rubella syndrome, characterized by eye defects resulting in blindness, hearing impairment, heart abnormalities, and/or mental retardation (ACOG, 2003b). Rubella infection during the first 16 weeks of pregnancy may also result in spontaneous abortion or stillbirth (MOD, 2007). Varicella, or chickenpox, a highly contagious infection, results from a DNA herpes virus infection (Seidman, 1996). Fetal varicella infection may result in stillbirth or congenital varicella syndrome, characterized by eye defects, limb hypoplasia, skin lesions, and central nervous system abnormalities (Seidman, 1996). Preconceptional Tdap vaccination is recommended. The Tdap vaccine immunizes against tetanus (infection of environmental *Clostridium tetani* spores through a skin-break leading to lockjaw and skeletal muscle rigidity), diphtheria (respiratory illness in which a grayish membrane covers the pharynx, palate, and nasal mucosa with possible airway obstruction), and pertussis (whooping cough) (Coonrod, et al., 2008). Preconceptional Tdap vaccination infers passive immunity for infants, who may be at risk of death if contracting these illnesses (Coonrod, et al., 2008). Preconceptional administration of the HPV vaccine, which is effective against certain strains of HPV that may lead to genital warts, cervical dysplasia, or cervical cancer, is important (Coonrod, et al., 2008). Certain diagnostic tests for HPV, such as endocervical curettage, and certain treatment options are contraindicated during pregnancy (Coonrod, et al., 2008). Reducing the risk of genital warts through vaccination prior to pregnancy potentially reduces perinatal transmission

and the incidence of laryngeal papillomatosis (tumors of the voicebox) in children of women infected with HPV (Saslow, et al., 2007). Also, HPV vaccination may reduce the need for loop electrosurgical excision procedure and cone biopsy, procedures that remove abnormal cells of the cervix and may impact cervical competence and performance during pregnancy (Crane, Delaney, & Hutchens, 2006). Preconceptional influenza vaccination is recommended. About 200,000 hospitalizations and 36,000 deaths may be attributed to influenza infection annually, and influenza during pregnancy increases the risk of morbidity and possible miscarriage (Harper, et al., 2005). In a nested case-control study, fetal influenza exposure in the first trimester was associated with a potentially increased risk of schizophrenia (Neuzil, et al., 1998). Preconceptional influenza immunization is recommended for women who will become pregnant during flu season and for women with increased risk for influenza-related complications, such as cardiopulmonary disease or metabolic disorders, prior to the beginning of flue season (Coonrod, et al., 2008). In summary, preconceptional vaccination of against hepatitis B, rubella, varicella, Tdap, HPV, and influenza maintains a woman's health and protects the health of her potential offspring.

Taking a thorough family medical history and an evaluation of the ethnic background of individuals may assist in screening for certain genetic conditions in potential offspring (Brundage, 2002). Blood tests are used to determine carriers of specific genes that cause genetic diseases (MOD, 2008b). If two genetic carriers of a disease conceive a child, there is a 25% chance that the child will inherit the disease (MOD, 2008b). The ethnic background of either partner may indicate recommended carrier-screenings for sickle cell trait (a blood disorder common among African-Americans), thalassemias (a blood disorder common among those of Mediterranean, African, and South Asian descent), and Tay-Sachs disease (a cause of fatal brain damage in those of Eastern European Jewish ancestry or non-Jewish individuals of

French-Canadian or Cajun ancestry) (Leuzzi & Scoles, 1996). A family history review including cystic fibrosis (a disease of the secretory glands, lung, and digestive system) or congenital hearing loss also may indicate carrier-screening tests (Cefalo & Moos, 1995). Preconceptional knowledge of genetic carrier status allows carriers an opportunity to understand the risk involved with potential pregnancies and to discuss their medical and childbearing options (MOD, 2008b).

As part of the family history, it is also important to note previous pregnancy outcomes (ACOG, 2007). Reviewing past experiences of miscarriage, complications, fetal birth defects, or stillbirth allows for potential interventions to prevent recurrence in future pregnancies (ACOG, 2007). Interventions may include specific medical tests to determine the cause of previous adverse pregnancy outcomes, and a preventive future approach to pregnancy can then be recommended (MOD, 2008b). For example, if a woman experienced a previous preterm delivery, her health provider may recommend lifestyle changes, such as quitting smoking, or subsequent treatment with the hormone progesterone may be recommended to assist in gestational maintenance (MOD, 2008b). Thus, a review of family history and previous pregnancy outcomes may lead to interventions resulting in improved future pregnancy outcomes.

Avoidance of toxic substances. A range of substances may be harmful to a fetus, and therefore, preconception health promotes limitations or avoidances of such toxic substances (Brundage, 2002). Common substances that are toxic to a developing fetus include cat feces, garden soil, raw meat, workplace/household chemicals, fish-related mercury, pesticides, high doses of vitamins A and D, and caffeine.
Cat litter, garden soil, and raw or undercooked meat are all associated with toxoplasmosis, a parasitic infection caused by *Toxoplasma gondii*. The toxoplasmosis parasite may cross the placenta if infection occurs during pregnancy, and fetal infection occurs in about 40% of maternal infection cases (Organization of Teratology Information

Specialists [OTIS], 2007b). Fetal infection may include problems with the brain, eyes, heart, kidneys, blood, liver, or spleen, and long-term effects may include seizures, mental retardation, cerebral palsy, deafness, and blindness (OTIS, 2007b). It is recommended that all women of reproductive age wear gloves when handling cat litter to avoid exposure to cat feces, wear gloves when gardening, and avoid eating raw or undercooked meat (Piper & Wen, 1999). Chemicals, household or in the workplace, may be harmful. Women should be made aware of hazardous materials in the workplace as a result of Occupational Safety and Health Administration's guidelines, and exposure to these substances should be avoided among women of reproductive age (Brundage, 2002). Hazardous over-the-counter chemicals found at home in cleaning products, certain foods, and pesticides may be inhaled, ingested, or even absorbed into the skin (Gjerdingen & Fontaine, 1991). Solvents may be teratogenic and harmful to pregnancy, such as those found in paint thinners, varnish remover, and oven cleaners (Gjerdingen & Fontaine, 1991). Extra strength cleansers should be avoided, and natural products may be substituted for most cleaning needs, such as baking soda and vinegar (MOD, 2003). Fish-related mercury may be harmful. Women can also be exposed to methylmercury by eating contaminated fish (OTIS, 2007c). Large fish have the highest levels of mercury, such as shark, swordfish, king mackerel, and tilefish (U.S. Environmental Protection Agency [EPA], 2008). The FDA and EPA advise that preconceptional women avoid such fish, as well as canned albacore tuna and fresh tuna steaks that typically have higher levels of mercury than canned light tuna (EPA, 2008). Women of reproductive age should limit cooked fish consumption to 12 ounces per week or less of fish low in mercury, such as salmon, catfish, pollock, canned light tuna, or shrimp (EPA, 2008). Women should also avoid pesticides whenever possible. Fetal risk has not been proven with pesticides at consumer household levels, but pesticides are poisonous and high levels have been associated with miscarriage, preterm delivery, and

birth defects (MOD, 2003). Women of childbearing age may use less toxic products, such as boric acid, for pest problems, as well as having others apply chemicals, avoiding pesticide use in and around the kitchen, reducing the use of insect repellents containing DEET, and wearing rubber gloves when gardening to avoid skin exposure to pesticides (MOD, 2003). Women of reproductive age may also choose to consume organically grown produce to avoid pesticide-contaminated fruits and vegetables (ACOG, 2009). Large quantities of vitamins A and D may be harmful. Fat-soluble vitamins A and D are also considered toxic when ingested in large quantities (Brundage, 2002). Vitamin A, when taken in doses of more than 10,000 international units per day, is teratogenic (ACOG, 2007). The FDA recommends a limit of 3,000 international units of vitamin A per day for preconceptional women (Brundage, 2002). Vitamin D, when taken in doses of 1,600 international units per day, may cause fetal hypercalcemia and growth retardation (Cephalo & Moos, 1995). Women of reproductive age should limit vitamin D intake to 400 international units per day alone or combined in calcium supplements or multiple vitamins (Brundage, 2002). Large quanitites of caffeine may be harmful. High doses of caffeine have been associated with increased risk of spontaneous abortion and low birth weight (Klebanoff, et al., 1999). Most authorities consider daily caffeine consumption of 300 mg safe, which is equivalent to two cups of coffee or six glasses of tea or soda (Klebanoff, et al., 1999). All of these are common substances in the United States, and limitations and avoidance recommendations are in place to protect the safety of women and their potential offspring (ACOG, 2007).

Domestic violence. Physical, emotional, and sexual abuse is dangerous for a mother and her fetus. Domestic violence, interpersonal violence, or intimate partner violence may be defined as threats or acts of physical, sexual, and/or emotional abuse between two person in a close relationship, such as current and former spouses or dating partners (CDC, 2008c). About 4.8 million intimate partner rapes and physical

assaults occur each year in the United States (Tjaden & Thoennes, 2000). According to the 2005 Behavioral Risk Factor Surveillance System, 23.6% of women over the age of 18 experienced interpersonal violence at some point in their lives and were more likely to report adverse health conditions and health risk behaviors (CDC, 2008d). Physical, sexual, and emotional abuse prior to pregnancy may put a woman at risk for abuse during the pregnancy (Klerman, et al., 2008). Martin and colleagues determined that 59% of women who were physically abused in the year prior to pregnancy continued to suffer physical abuse during pregnancy (Martin, et al., 2001). Interpersonal violence is also associated with adverse health conditions that my affect pregnancy, such as inconsistent contraception use, unplanned pregnancy, sexually transmitted infections, depression, and posttraumatic stress disorder (Coker, 2007; Kendall-Tackett, 2007). Some evidence indicates that intimate partner violence may lead to poor pregnancy outcomes, such as low birthweight and preterm delivery (Sharps, Laughon, & Giangrande, 2007; Silver, Decker, Reed, & Raj, 2006). The emotional and psychological impact associated with intimate partner violence may also interfere with a healthy pregnancy (Klerman, et al., 2008). Pregnant victims of sexual violence, within or outside of a domestic situation, may experience severe depression and use cigarettes, alcohol, or illegal drugs to cope during the pregnancy (McMahon, Goodwin, & Stringer, 2000). The severity of sexual violence may increase the risk of poor reproductive health outcomes (McMahon, Goodwin, & Stringer, 2000). However, preconception identification of those women in previous abusive relationships and current abusive relationships can instigate treatment and minimize potential adverse pregnancy outcomes (Klerman, et al., 2008). McFarlane and colleagues determined that interpersonal violence might be reduced through the use of abuse assessment, the provision of information about sources of assistance, the provision of safety plans, and a nurse case management protocol (McFarlane, Groff, O'Brien, & Watson, 2006).

Avoidance of stress. Stress is detrimental to health and a potential pregnancy. Allostasis is the body's capacity to maintain stability through change (Klerman, et al., 2008). Psychosocial stress may alter allostasis, and repeated and chronic stress may lead to allostatic system deterioration (Klerman, et al., 2008). Examples of allostatic systems include the inhibition of the hypothalamic-pituitary-adrenal (HPA) axis that keeps the body's stress response in check and modulates the inflammatory response (Chrousos, 2000; McEwen, 1998). An impaired allostatic system at the onset of pregnancy may be associated with pregnancy complications, such as preterm delivery (Klerman, et al., 2008). Therefore, preconception control of perceived stress is important to optimize pregnancy outcomes (Klerman, et al., 2008).

Inadequate financial resources are common stressors among women of reproductive age (Klerman, et al., 2008). About 13% of women between 18 and 64 years of age have incomes that place them below the federal poverty level (U.S. Census Bureau, 2007). Poverty increases among women of reproductive age (U.S. Census Bureau, 2007). Between 18 and 24 years of age, 21% and 42% of women have incomes that place them below the federal poverty level and of low-income status (below 200% of the poverty level), respectively (U.S. Census Bureau, 2007). Between 25 and 44 years of age, 15% and 34% of women have incomes that place them below the federal poverty level and of low-income status (below 200% of the poverty level), respectively (U.S. Census Bureau, 2007). Women living in poverty or with low-income status may find it difficult to obtain food, shelter, and other necessities, which may lead to physical stress, psychosocial stress, and poor pregnancy outcomes (Huynh, et al., 2005; Haas, Meneses, & McCormick, 1999).

Another common stressor among women of reproductive age is the inability to easily access healthcare. Access issues may include lack of insurance, an inadequate number of providers, an inadequate number of providers who accept Medicaid, and

transportation issues (Klerman, et al., 2008). Of the 94.7 million women in the United States between 18 and 64 years of age in 2007, 18% were uninsured and 10 were on Medicaid (Kaiser Family Foundation [KFF], 2008). Eligibility for Medicaid is reserved for low-income women who are either pregnant, mothers of children 18 years of age or younger, disabled, or over 65 (KFF, 2008). Women without children and disabilities are usually ineligible regardless of poverty status, and women over 65 years of age are typically eligible to receive Medicare (KFF, 2008). Medicaid finances 41% of all births in the U.S., and it accounts for 71% of all publicly funded planning services (Sonfield, Alrich, & Gold, 2009). Many women, however, lose their Medicaid status by 60 days after delivery, leaving them uninsured unless they qualify for further federal or state assistance (Klerman, et al., 2008). Women without insurance are more likely to postpone care, forgo filling prescriptions, and eliminate preventive care, such as Pap smears (KFF, 2008). Compared to women with private or public insurance, uninsured women are less likely to have visited a healthcare provider within the last year and more likely to experience poor health outcomes (Salganicoff, Ranji, & Wyn, 2005).

Avoidance of hyperthermia. Hyperthermia may be dangerous to a developing fetus. Typically, normal human body temperature averages about 98.6 degrees Farenheit (OTIS, 2006). During pregnancy, 101 degrees Farenheit may be cause for concern (OTIS, 2006). The effects of elevated body temperature during pregnancy depend upon the extent of elevation, the duration, and the stage of fetal development in which it occurs (Edwards, 2006). Most studies regarding hyperthermia and pregnancy delineate hyperthermia exposure as a body temperature of 102 degrees Farenheit for an extended period of time (OTIS, 2006). Hyperthermia results most often from fever during an illness, but very heavy exercise or prolonged exposure (more than ten minutes) to heat sources such as hot tubs, very hot baths, or saunas can also elevate body temperature (OTIS, 2006). Prenatal death and abortion may result from mild

exposure prior to implantation or severe exposures during embryonic and fetal develoment (Edwards, 2006). Central nervous system defects may occur including neural tube defects, microphthalmia (abnormal smallness of the eye), cataracts, microencephaly (abnormal smallness of the head), and other structural and functional defects may include defects of craniofacial development, the bones, the teeth, and the heart (Edwards, 2006). Prior to and during pregnancy, prolonged exposure to elevated body temperatures should be avoided (OTIS, 2006).

Frequent handwashing. The powerful impact of handwashing is often overlooked in the public arena, but this simple habit is extremely effective in reducing the spread of infectious disease (Mayo Clinic, 2007). Frequent handwashing prevents the hand-to-hand or hand-to-infected surface spread of germs related to the common cold, flu, gastrointestinal disorders, and food-related illnesses such as salmonella and *E. coli* infection (Mayo Clinic, 2007). This review has expounded on the potential harmful fetal effects that may result from infection (e.g., common cold, flu, *E. coli*) and toxic substances (e.g., garden soil, cat or rodent feces) (MOD, 2008; Mayo Clinic, 2007). Frequent handwashing diminishes the resulting risk of infection or contamination and is essential among women of reproductive age (MOD, 2008).

Lack of consensus. In summary, there are numerous preconception health components that impact pregnancy outcomes. However, leading public health agencies poised to develop and implement preconception health education and policies have failed to come to a consensus regarding the necessary components for inclusion in preconception health. This inconsistency hinders further development of the preconception health movement. The aim of preconception health is to reduce infant morbidity and mortality above and beyond the preventive impact of prenatal care.

Prenatal Care

Prenatal care is generally described as the health care a woman receives during pregnancy (March of Dimes, 2009; U.S. Department of Health and Human Services [DHHS], 2009; Mayo Clinic, 2008). Prenatal care may address maternal education, counseling, and the teaching of basic parenting skills (U.S. National Library of Medicine & National Institutes of Health, 2009), and it typically includes the monitoring of a pregnancy for potential maternal or fetal problems that may occur (Hood, Parker, & Atrash, 2007). According to *Healthy People 2010,* about 74% of women obtain early and adequate prenatal care (DHHS, 2000). Inadequate prenatal care is associated with higher infant mortality rates, with a 1.8-fold increase among black women and a 1.6-fold increase among white women (Vintileos, et al., 2002). In addition, prenatal care is associated with infant morbidity (Wilson, et al., 1992). Inadequate prenatal care (no prenatal care, late prenatal care initiation [only third trimester], or less than five of the recommended 13 minimum prenatal visits) is significantly associated with increased Neonatal Intensive Care Unit (NICU) admission rates (5.1% with inadequate prenatal care vs. 2.9% with adequate prenatal care; $p < .001$) (Wilson, et al., 1992).
Prenatal care alone, however, fails to prevent certain fetal development and maternal health risks. During fetal development, the fourth through the tenth week after conception is the most critical window in which the fetus is susceptible to potential health problems. Usually, prenatal care begins in the eleventh or twelfth week of pregnancy, thus failing to prevent early embryonic developmental abnormalities and failing to reduce numerous health risks to the mother (CDC, 2006c). Half of all infant deaths are attributed to four causes: 1) congenital malformations/birth defects; 2) disorders related to prematurity and low birth weight (LBW); 3) sudden infant death syndrome (SIDS); and 4) maternal complications of pregnancy (Arias, MacDorman, Strobino, & Guyer, 2003; Bennett & Kotelchuck, 2005). Research indicates that prenatal care alone is insufficient

to effect necessary change in these contributors to infant mortality, thus explicating the need for other prevention strategies, such as preconception care (DHHS, 2000; Korenbrot, Steinberg, Bender, & Newberry, 2002). Due to the impact of prenatal care on adverse pregnancy outcomes, prenatal care factors (initiation of prenatal care, prenatal education, maternal complications, and tobacco and alcohol use during pregnancy) will be integrated into the conceptual framework of this study.

Postnatal Care

Postnatal care is less defined than prenatal care, but certain postnatal practices are known to reduce the risk of infant mortality. Infant mortality is defined as the number of infant deaths per 1,000 live births, and an infant is defined as one year of age or younger (MacDorman & Mathews, 2008). The ten leading causes of death for infants in 2005 in the United States (CDC, 2007f) are as follows:

1) Congenital malformations/birth defects
2) Disorders related to short gestation and low birthweight
3) Sudden infant death syndrome (SIDS)
4) Newborn affected by maternal complications of pregnancy
5) Newborn affected by complications of placenta, cord, and membranes
6) Unintentional injuries
7) Respiratory distress of newborn
8) Bacterial sepsis of newborn
9) Neonatal hemorrhage
10) Necrotizing enterocolitis of newborn

Infant mortality may be divided into two categories: 1) neonatal mortality and 2) postneonatal mortality.

Neonatal mortality refers to the number of deaths among infants less than 28 days of age per 1,000 live births (Health Resources and Services Administration

[HRSA], 2009). In this study, it is possible that variables for neonatal intensive care unit use and length of hospital stay may serve as a proxy for neonatal complications contributing to neonatal death, such as respiratory distress, bacterial sepsis, hemorrhage, and necrotizing enterocolitis. Other risk factors for neonatal death, such as low birthweight, preterm delivery, small for gestational age, and maternal complications will be included in the framework, as well.

Postneonatal mortality, or the number deaths among infants between 28 days of age and one year of age per 1,000 live births, may include those deaths attributed to SIDS, unintentional injury, and possibly birth defects (HRSA, 2009). SIDS cases may be defined as sudden deaths of infants under one year of age, which remain unexplained after autopsy, death scene investigation, and a review of the clinical history (AAP, 2005). SIDS is the leading cause of death in children between one month and one year of age (NIH & NLM, 2009b). In 1992, the AAP recommended that infants be placed in a nonprone (back or side) position for sleep to reduce the incidence of SIDS (Kattwinkel, et al., 1992). In 2000, with new evidence about SIDS risks, this recommendation was revised to state that placing an infant on its back was the preferred sleep position (AAP, 2005). The rate of SIDS decreased from 1.20 deaths per 1,000 live births in 1992 to 0.56 deaths per 1,000 live births in 2001 (CDC, 2005c). This reduction in SIDS incidence is controversial, with some researchers citing that the reduction is the direct result of changes in the coding of SIDS deaths (AAP, 2005). Regardless, sleep position, low birth weight, race, overheating, birth in the fall or winter months, maternal tobacco use after delivery, and exposure to environmental tobacco smoke are known risk factors for SIDS (Mayo Clinic, 2009; AAP, 2005).

Postnatal infant feeding practices may also impact adverse pregnancy outcomes. Breastfeeding is associated with a decreased risk of neonatal and postneonatal mortality (AHRQ, 2009; Chen & Rogan, 2004). A history of breastfeeding is associated with

reduced risk of otitis media, non-specific, gastroenteritis, severe lower respiratory tract infections, atopic dermatitis, asthma, obesity, type 1 and 2 diabetes, childhood leukemia, SIDS, and necrotizing enterocolitis (Ip, et al., 2007). An increase in infant mortality is also associated with a delay in breastfeeding initiation and with an increased degree of supplementary (formula) feeding (Edmond, 2006; Guttmacher Institute, 2006). Due to the possible impact of postnatal care on infant mortality, postnatal care factors (infant sleep position, infant feeding practices, infant medical care, postnatal tobacco use, and infant smoke exposure) will be integrated into the conceptual framework of this study. Factors impacting unintentional injury and birth defects are not included in the PRAMS dataset, and therefore, will be excluded from the framework.

Identifying the Gaps

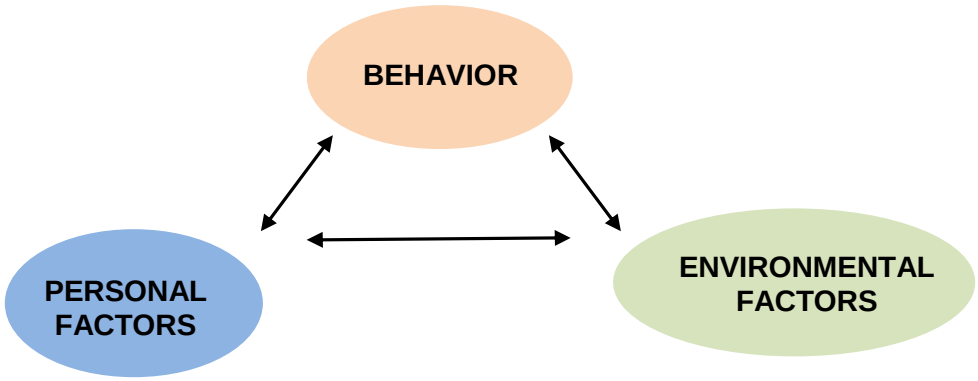
The empirical literature clearly demonstrates the impact of independent preconception health behaviors on adverse pregnancy outcomes. However, preconception health does not occur in a vacuum. There is a gap in the literature demonstrating the effectiveness of preconception health as a whole on reducing adverse pregnancy outcomes, especially in the context of extenuating environmental and personal influences. This study examines the impact of preconception health on adverse pregnancy outcomes through the lens of reciprocal determinism, thereby developing a preconception health conceptual framework that accounts for the interactive relationships between behavior, the environment, and the person.

Reciprocal Determinism

History. In the early 20th century, the theoretical perspective of behaviorism began to gain ground in the field of psychology (Van Wagner, 2005). During this time period, Pavlov discovered classical conditioning, or that conditioned associations could facilitate the learning of behaviors (Van Wagner, 2005). Watson further delineated the effects of behavioral conditioning, and Skinner then introduced the concept of operant

conditioning, or the impact of a system of rewards and punishment on behavior (Van Wagner, 2005). In the middle of the 20th century, Albert Bandura critiqued the concept of behavioral conditioning because of its sole reliance on environmental influence (Bandura, 1986). Bandura stated that the basis for human behavior is neither instinctual as posited by Plato and Aristotle, nor a response to external stimuli as posited by Skinner (Bandura, 1986). Rather, behavior is influenced by the interaction of multiple determinants that exist in the environment and within the individual (Bandura, 1986). Bandura determined that environmental factors and personal factors interact with behavior in a dynamic, triadic model of reciprocity, or reciprocal determinism (Figure 2) (Bandura, 1986).

Figure 2. A graphic representation of reciprocal determinism - Bandura (1986).



Within this model, behavior may be characterized as observable, intentional, and goal-directed actions or as the required skills for behavior performance (Bandura, 1986). Environmental factors may include physical surroundings or social influences (Bandura, 1986). Personal factors may include cognition, affect, and constitutional makeup (Bandura, 1986). The reciprocal nature of the model intimates bidirectional influences between these determinants (Bandura, 1977; 1986; 1989). For example, in relation to the person-behavior relationship, an individual's actions may be influenced by his or her

biological properties, such as sex, ethnicity, temperament, and genetic makeup, as well as self-perceptions, emotions, and thoughts (Bandura, 1977; 1986; 1989). In a reciprocal fashion, performance of a behavior may influence an individual's emotions or thoughts (Bandura, 1977; 1986; 1989). When dealing with the environment-person relationship, an individual's beliefs and expectations may be influenced by his or her social circumstances (Bandura, 1977; 1986; 1989). Reciprocally, the physical characteristics of an individual, such as age, size, race, sex, physical attractiveness, may influence his or her social environment (Bandura, 1977; 1986; 1989). With regard to the environment-behavior relationship, an individual determines his or her environmental exposure, and the environment then modifies his or her behavior (Bandura, 1977; 1986; 1989). Thus, an individual is a product of the environment that he or she produces (Bandura, 1977; 1986; 1989). In a reciprocal fashion, behavior may impact the environment, such as the creation of a hostile environment by an aggressive individual (Bandura, 1977; 1986; 1989). Reciprocal determinism is consistent with the principle of a system in that a change in one determinant yields a change in another determinant (Bandura, 1986). However, these interactive influences are not necessarily equal in strength, as some interactions exert more influence than others (Bandura, 1989). And, these interactions are not necessarily simultaneous, but most often occur sequentially over time (Bandura, 1989). Reciprocal determinism is a principle, or postulate, that is commonly recognized as a central tenet of the Social Cognitive Theory (formerly known as the Social Learning Theory) (Baranowski, Perry, & Parcel, 1997).

Applications in public health. Though not widely used on its own, several studies have used the principle of reciprocal determinism to provide a structural basis for the conceptual organization of the empirical literature or the development of a conceptual framework (Perrin & Swerissen, 2008; Reddan, Wahlstrom, & Reicks, 2002). A conceptual framework may be defined as a visual diagram consisting of a set of key

factors, concepts, or variables, a given outcome, and the presumed associations therein (Bertrand, 2006; Miles & Huberman, 1994). Conceptual frameworks, attempt to explain what is happening and why (Maxwell, 2004). The development of conceptual frameworks relies on the use of theory, empirical evidence, and experiential knowledge to assimilate knowledge, to explain causal associations, and to generate hypotheses (Bertrand, 2006).

Perrin and Swerissen (2008) used the reciprocal determinism postulate to develop a model of behavioral and psychological influences and interactions regarding people at risk for diabetes-related foot complications. In this study, the researchers conducted a literature review and organized the numerous studies found according to the principle of reciprocal determinism (Perrin & Swerissen, 2008). This allowed the researchers to include multiple contributing factors, and the researchers determined that demographic variables predispose persons to certain beliefs, attitudes, and knowledge, which influence foot monitoring and protective actions (Perrin & Swerissen, 2008). The environment and social situations also immediately impacted behavior and the cognitions that followed (Perrin & Swerissen, 2008). This study did not evaluate the developing framework from a statistical perspective, but the framework cohesively synthesized a large number of studies to identify factors that shape appropriate foot care behavior.

Other researchers used the reciprocal determinism principle to identify benefits and barriers related to breakfast consumption by children (Reddan, Wahlstrom, & Reicks, 2002). Reddan et al. (2002) built upon previous studies associated with influential factors of children's eating behavior, and then used the reciprocal determinism construct in combination with student interviews to develop a comprehensive framework. Chi-square tests were performed to analyze statistical differences between determinants. Statistically significant perceived benefits were determined to be

increased energy and ability to pay attention in school and significant perceived barriers included the lack of time to eat and lack of student hunger in the morning. These results reiterated the findings found in the empirical literature. However, the interactions of the environmental and psychological influences on behavior indicate that adjustments may be made to improve breakfast consumption in this population. The researchers recommended further use of the reciprocal determinism postulate to develop practical strategies to address the determined barriers to breakfast consumption among children (Reddan, et al., 2002). Several other studies support the use of the principle of reciprocal determinism to enhance the understanding of relationships among multiple influential factors and their associations with a given outcome (Read, Wood, & Capone, 2005; Pakenham, Dadds, & Lennon, 2002; Makoul, 1998; Pakenham, Dadds, & Terry, 1995).

Application in this study. In this study, preconception health will be addressed according to the theoretical principle of reciprocal determinism via behavioral, environmental, and personal influences on adverse pregnancy outcomes. Behavioral influences will include those behaviors that can be performed prior to pregnancy to reduce adverse pregnancy outcomes, also known as preconception health behaviors: weight management (measured via BMI), folic acid use, avoidance of tobacco, avoidance of alcohol, obtaining oral care, obtaining medical care, and contraceptive use. Personal influences will include cognitive and constitutional factors that may impact adverse pregnancy outcomes: pregnancy intention, maternal age, race/ethnicity, and previous pregnancy outcomes. Environmental influences will include preconceptional factors beyond a woman's volitional control and socioeconomic factors that may impact adverse pregnancy outcomes: income status, health insurance status (with the exception of Medicaid), Medicaid status, education level, external stress, and physical abuse. Among these groups, several factors have not been previously discussed, such

as pregnancy intention, demographic characteristics, and contraceptive use. According to the principle of reciprocal determinism and their empirical effects on adverse pregnancy outcomes, they will be included in this study.

Pregnancy intention. In the United States, about half of all pregnancies are unintended (Finer, 2006). An unintended pregnancy may be categorized as either mistimed or unwanted at the time of conception (Santelli, et al., 2003; Klerman, 2000). A mistimed pregnancy occurs sooner than planned, and an unwanted pregnancy is not wanted at the time of pregnancy or at any time in the future (Keeton & Hayward, 2007). Due to small sample size and failure to account for strong cofounders, there is an inconsistency among studies linking unintended pregnancies with adverse pregnancy outcomes, such as low birth weight and preterm delivery (D'Angelo, et al., 2004; Pulley, et al., 2002; Eggleston, 2000; Gazmararian, et al., 2000; Orr, et al., 2000; Kost, Landry, & Darroch, 1998a; Sharma, et al., 1994; De Muylder, et al., 1992; Cartwright, 1988). According to a study conducted using data from the Maternal and Infant Health Survey and the National Survey of Family Growth, adverse pregnancy outcomes were not associated with mistimed pregnancies when controlling for selected maternal sociodemographic characteristics, but unwanted pregnancies increased the likelihood of adverse pregnancy outcomes in the same controlling conditions (Kost, Landry, & Darroch, 1998a). However, this association between unwanted pregnancies and adverse pregnancy outcomes was no longer significant when accounting for selected maternal prenatal behaviors, such as smoking during pregnancy (Kost, Landry, & Darroch, 1998a). In another study, Pregnancy Risk Assessment Monitoring System data were used to determine the associations between pregnancy intention and adverse birth outcomes among 87,087 women (Mohllajee, Curtis, Morrow, & Marchbanks, 2007). These researchers, after controlling for selected demographic and prenatal behavioral factors, demonstrated that women with unwanted pregnancies were more likely to

experience a preterm delivery (adjusted OR 1.16 [95% CI 1.01, 1.33]) and women with mistimed pregnancies were less likely to experience a preterm delivery (adjusted OR 0.92 [95% CI 0.86, 0.97]) than women with intended pregnancies (Mohllajee, Curtis, Morrow, & Marchbanks, 2007).

Pregnancy intention varies with maternal behavior (Keeton & Hayward, 2007). Regarding preconception maternal behaviors, women with unintended pregnancies were more likely to report cigarette smoking (adjusted OR 1.50 [95%CI 1.28, 1.75]) and less likely to report daily vitamin supplement use (adjusted OR 0.66 [95%CI 0.58, 0.76]) when compared to women with intended pregnancies (Hellerstedt, et al., 1998). Regarding prenatal maternal behaviors, women with unintended pregnancies were more likely to report smoking (OR 1.4 [95% CI 1.2, 1.7]), illicit drug use (OR 3.4 [95% CI 1.9, 6.4]), not taking daily vitamin supplements (OR 1.4 [95% CI 1.2, 1.7]), and alcohol use (OR 1.2 [95% CI 0.99, 1.4]) than women with intended pregnancies (Than, et al., 2005). Women with intended pregnancies are also more likely than those with unintended pregnancies to recognize the early signs of pregnancy and seek out early prenatal care (Kost, Landry, & Darroch, 1998b).

Pregnancy intention also varies among demographic subgroups (Keeton & Hayward, 2007). There is an increased risk of unintended pregnancy among women with less than a high school education, among adolescents, and among black women (Chandra, et al., 2005; Than, et al., 2005). According to an older study conducted with data from 1988 National Survey of Family Growth, increased risk of unintended pregnancy status was also associated with never being married, women living below the federal poverty level, and women with more than two children, in addition to the aforementioned risk factors, when compared to women with intended pregnancies (Kost & Forrest, 1995). Overall, pregnancy intention is associated with preconception behavioral and environmental factors, and it may also relate to adverse pregnancy

outcomes. Pregnancy intention will be included in the conceptual framework of this study.

Demographic characteristics. Adverse pregnancy outcomes may have a direct or an indirect relationship with selected demographic characteristics. Low birth weight (LBW) rates may vary by race or ethnic status (Shiao, Andrews, & Helmreich, 2005). In 2001, the low birth weight rate for black women was 10.4% (Shi, et al., 2004). Black women of low socioeconomic status (SES) demonstrated a LBW rate 5.8% higher compared to white women in the same SES group and 6.2% higher compared to the total U.S. population (Shi, et al., 2004). Also in 2001, the infant mortality rate decreased from 7.2 to 6.8 deaths per 1,000 live births; however, the infant mortality rate for black infants was 13.5 deaths per 1,000 live births, the highest of any racial group (Beato, 2003). In another study, increasing maternal age (among women 15 to 34 years of age) of black women was associated with increased rates of low birth weight and very low birth weight infants, whereas white women did not experience this association (Geronimus, 1996). Black women in low-income areas that were 34 years of age were three times as likely to have a low birth weight infant and four times as likely to have a very low birth weight infant than low-income black women that were 15 years of age (Geronimus, 1996). Geronimus explains this as a weathering hypothesis among the African-American population, or that the effects of social inequality on health may compound with maternal age, thus impacting fetal health (Geronimus, 1992). Low birth weight and other adverse pregnancy outcomes also may vary by maternal age (Shiao, Andrews, & Helmreich, 2005). On the maternal reproductive age spectrum, the youngest and oldest mothers exhibit the highest rates of LBW (Jolly, et al., 2000a, 2000b; Martin, et al., 2003). Low birth weight rates were significantly higher among nulliparous young women (17 years of age or less) than those born to women between 20 and 24 years of age (Abu-Heija, Ali, & Al-Dakheil, 2002). Those women 35 years of

age or older are associated with an increased risk of preterm delivery, cesarean delivery, low birth weight, fetal distress, and infant admission to the NICU compared to younger women (Ziedeh, 2002; Yuksel, et al., 1996). Low birth weight rates were also significantly associated with lower gestational age and lack of adequate health insurance (Hunter & Taslimi, 2008). The possible effects associated with income status and health insurance on pregnancy outcomes were also previously mentioned in the discussion of environmental stressors.

Maternal age is also associated with adverse maternal behaviors (Weisman, et al., 2006). Among preconceptional and interconceptional women, women between 18 and 34 years of age experienced binge drinking, nutritional deficits, physical inactivity, increased gynecologic infections, and more psychosocial stress than older women (Weisman, et al., 2006). Women between 35 and 45 years of age also experienced binge drinking, nutritional deficits, and physical inactivity, but they also were more likely to have chronic conditions like hypertension and high cholesterol compared to younger women (Weisman, et al., 2006). Overall, demographic characteristics are associated with preconception behavioral and personal factors, and they may relate to adverse pregnancy outcomes. Maternal age, race/ethnicity, education, insurance status, and income status will be included in the conceptual framework of this study.

Use of contraception. A discussion of contraceptive use logically ensues a discussion related to the high rates of unintended pregnancy in the United States, and there is a vast body of research devoted to the use of contraceptives. However, in the preconception health literature, discussion of contraception is minimal. Despite the Center for Disease Control and Prevention's vast amount of work dedicated to preconception health in the last decade, contraception is only briefly mentioned in reference to the development of a reproductive life plan (CDC, 2006). Other preconception promotion materials never mention the use of contraception ((MOD,

2009a, 2009b, 2008; ACOG, 2007; Brundage, 2002). Some preconception advocates may view contraceptive use as independent of preconception health promotion, and therefore, that additional discussion of contraceptives in relation to preconception health is not warranted. Due to possible contraceptive failure, contraceptive use does not negate the need for preconception health promotion. Of the approximately 62 million women of reproductive age, about 43 million are sexually active and do not want to become pregnant (Guttmacher Institute, 2008). The average woman in the United States desires to have only two children, and therefore, must rely on contraceptive use for the majority of nearly three decades of her life to prevent unintended pregnancy (Guttmacher, 2008). Whereas preconception health addresses preventive behaviors that may be performed in case of pregnancy, regardless of intention, contraception addresses the only the prevention of pregnancy. Contraceptive use will be included in the conceptual framework of this study. Note that not all of the preconception health components and subcomponents previously discussed are included in this study due to limitations with the Pregnancy Risk Assessment Monitoring System dataset.

Pregnancy Risk Assessment Monitoring System Survey

The Pregnancy Risk Assessment Monitoring System (PRAMS) surveillance project of the CDC will be used in this analysis. The PRAMS project collects population-based data from 37 states, one city, and an American Indian tribal territory regarding maternal experiences before, during, and shortly after pregnancy to inform the development of state health programs designed to improve maternal and infant health (CDC, 2009). Surveys, like the PRAMS questionnaire, are useful tools in the examination of characteristics of a large population, and they provide a relatively quick, standardized method of data collection (Creswell, 2003).

PRAMS development. The CDC first developed the topics and questions comprising the PRAMS questionnaire in 1988 (CDC, 2008f). Focus groups and in-depth

interviews were used to pretest the questionnaire. Interviews were based on the cognitive techniques developed by Jobe and Mingay (1989). Cognitive interviewing aims to enhance questionnaire validity by improving item structure according to the way respondents structure information in their memory (CDC, 2008f). In cognitive interviewing, the respondent reads each survey question aloud, paraphrases it, states her answer, reads the response options aloud, marks her choice, and explains her thinking (Adams, et al., 1991). This process allows the researcher to detect readability issues. The PRAMS survey demonstrated about an eighth-grade reading level. After 1,000 questionnaires were completed, responses were systematically reviewed for greater than 10% of item nonresponse, greater than 90% of similar item responses, or items with a high number of written answers. Items were modified accordingly.
Since then, the items of the PRAMS questionnaire undergo continuous revision, with major revisions in 1990, 1995, 1999, 2001 (mini-revision), and 2004. These revisions delineate the five phases of PRAMS. Content areas of PRAMS are developed based upon the following criteria (CDC, 2008f):

1. Usefulness of information to develop specific interventions aimed at reducing infant morbidity and mortality.
2. The likelihood that valid and sensitive information can be collected from the mother shortly after delivery.
3. Estimated prevalence of behavior, attitude, or experience.
4. Strength of associations between behavior, attitude, or experience and infant morbidity and mortality.
5. Importance of covariation of information for the association between behavior, attitude, or experience and infant morbidity and mortality.
6. Availability of state-level information from other data sources.
7. State need for information for 2010 health objectives or other program needs.

The CDC provides basic advice to participating states about item wording and structure, and the CDC and states pretest newly developed and modified questions. Cognitive interviewing techniques are used by the National Center for Health Statistics Questionnaire Design Research Laboratory to evaluate core and standard-state questions and by the states to evaluate the state-developed questions. All cognitive interviewing revisions made at the CDC or state-level are subsequently subjected to field testing to ensure appropriateness. Samples for both types of pretesting are carried out by mail and telephone, in English and Spanish, among 20 to 25 women of varying sociodemographic backgrounds. Due to the variation in state PRAMS questionnaires, the final step in the pretesting process is to conduct a flow assessment in each state of the final state-specific questionnaire. To do this, mail and telephone surveys in English and Spanish are tested via a convenience sample of coworkers, friends, and family to ensure smooth flow of the questionnaire. All state pretesting procedures are outlined and approved by the CDC prior to implementation. Due to the inclusion of over 200 indicators, validation of the PRAMS survey relies on pretesting and evaluation of individual questions (D'Angelo, D.V., November 13, 2009).

PRAMS data collection. Due to the large number of states administering the PRAMS survey, a standardized data collection methodology was developed. Some portions of the required protocol are customizable to tailor the procedures to state-based needs. Sources of data for PRAMS surveillance are obtained from birth certificate data, operational data, and questionnaire data. Birth certificates are used as a sampling frame, to weight survey data for population representativeness, and to obtain demographic information about the survey participants. PRAMTrac, a software system developed by the CDC to assist with PRAMS data collection, generates operational data. This operational data is used to calculate response rates and monitor the quality

of data collection. Questionnaire data includes self-reported data collected using Dillman's Tailored Design Method (Dillman, 2000).

Dillman's Tailored Design Method is used in survey research as a tested approach to increasing response rates for mail surveys by contacting participants in numerous and varied ways (Dillman, 2000). Using this method, PRAMS surveillance includes the following sequential contacts with sampled mothers:

1. Preletter (Day 1): An introductory letter explaining PRAMS and the subsequent arrival of the questionnaire.
2. Initial Mail Questionnaire Packet (3-7 days later): Contains a multipurpose cover letter describing PRAMS, its purpose, and an explanation of how and why the participant was selected. It also elicits participant cooperation, describes procedures of response, explains incentives and rewards, and provides a telephone number for additional information. In 2004, the letter was divided into two parts: an introductory letter and an informed consent information sheet. Following the multipurpose cover letter, a questionnaire booklet is included in the packet. Each state may customize the colorful cover art of the booklet. The booklet is no more than 14 pages in length and is slightly smaller than 8 ½" X 11". An extra page is attached at the end for any participant comments. The packet also includes a self-addressed postage-paid return envelope for easy return of the questionnaire, an informational PRAMS brochure with answers to frequently asked questions, a three-year calendar for a memory aid, and some type of incentive or reward selected by the state. Examples of incentives and rewards include coupons for certified birth certificates, a raffle card for a possible cash reward, postage stamps, bibs, a one-dollar bill, and magnetic picture frames.
3. Tickler (7-10 days later): A thank you and reminder note.

4. Second Mail Questionnaire Packet (7-14 days later): Sent if no response. Same as the initial mail questionnaire packet, with an additional appeal for response in the cover letter.
5. Third Mail Questionnaire Packet (7-14 days later): Sent if no response. Same as the second mail questionnaire packet.
6. Telephone Follow-up (7-14 days later): Call made if no response. Telephone numbers are identified through a variety of sources varying by state. To increase possible participant availability, calls made over a period of two to three weeks are staggered throughout the day on varying days of the week. Up to 15 calls are made in an attempt to reach a participant, and telephone interviewers often schedule call-back times to fit the mother's schedule. By September 2006, all states used Computer Assisted Telephone Interviewing (CATI) software for telephone follow-up.

Each month in each state, a systematic stratified sample of eligible birth certificates is drawn from the birth certificate file, and the above sequence of contacts is made with each selected participant. The total data collection cycle from the pre-letter mailing to the follow-up telephone call lasts between 60 to 95 days. PRAMTrac software is used to assist with mail and telephone call scheduling, letter preparation, and tracking of responses. PRAMS response rates of 70% from each state are required for each sampling stratum. In 2005, 26 out of 28 PRAMS projects achieved a response rate of 70% or higher, and six of these states met or exceeded an 80% response rate. Higher response rates minimize nonrandom or systematic error from response bias. In addition, PRAMS uses larger sample sizes than those needed to obtain a given precision level in epidemiologic measurements. These larger samples sizes help reduce the amount of random error associated with the estimates obtained from PRAMS data. Also, demographic characteristics and some medical information for nonrespondents may be

obtained from the birth certificates used to locate them. The CDC calculates weights after data collection to adjust for possible error in sampling, nonresponse, and frame noncoverage. Sampling and instrumentation will be discussed in further detail in the next chapter. In 1991, the cost of data collection and management for PRAMS varied from $75,000 to $94,000 per state (Adams, et al., 1991). These costs vary based upon sample size, staff salaries, and processing costs. These figures do not account for one-time costs related to the development of study protocol, the questionnaire, the PRAMTrac software, or data analysis.

Since the early 1990s, over 70 journal articles and numerous surveillance reports have been generated using PRAMS data (CDC, 2008e). The CDC monitors the multi-state use of all PRAMS research data, and generated output primarily involves correlational studies and prevalence estimates (CDC, 2008e). Research involving PRAMS data incorporates topics ranging from breastfeeding trends to the perinatal impact of smoking to maternal depression. Two CDC-based reports used PRAMS data to assess the prevalence of preconception and interconception indicators in 1999 (Beck, et al., 2002) and 2004 (D'Angelo, et al., 2007). In the 2004 surveillance summary, 18 behaviors and conditions were deemed relevant to preconception health and health care (D'Angelo, et al., 2007). In relation to preconception maternal behaviors and experiences, mean overall prevalence was 23% for tobacco use, 50% for alcohol use, 53% for nonuse of contraception among women not trying to become pregnant, 35% for multivitamin use at least four times a week, 78% for ever having a dental visit prior to pregnancy, 30% for receiving preconception health counseling, 3.6% for experiencing physical abuse, and 19% for experiencing at least four stressors prior to pregnancy. Regarding preconception maternal conditions, mean overall prevalence was 13% for women being underweight, 13% for women being overweight, and 22% for women being obese; 1.8% for diabetes; 6.9% for asthma; 2.2% for hypertension; 1.2% for heart

problems; and 10% for anemia. Previous pregnancy outcomes exhibited mean overall prevalence of 12% for having a previous low birth weight infant and 12% for having a previous preterm infant (D'Angelo, et al., 2007). As indicated in this study, whereas preconception maternal behaviors and conditions may be improved upon among women in the United States, it also may be determined that the PRAMS represents a conditionally optimal dataset to examine such behaviors and conditions in relation to adverse pregnancy outcomes. The condition that prevents the PRAMS data from achieving optimal status is the variability of optional standard state and state-specific questions. This hindrance will be evident in the distinction between Projects 1 and 2 of the proposed study. Project 2 requires the exclusion of two variables, obtaining oral care and obtaining medical care, due to limitations of standard state questions. Both projects of this study also require exclusion of certain preconception maternal conditions, such as diabetes, asthma, hypertension, heart problems, and anemia due to instrumentation limitations.

Summary

The preconception health movement began with the rationale that many adverse pregnancy outcomes are determined prior to prenatal care initiation (Moos, 2006). Thus, in addition to prenatal care, the need for preconception health arose. The empirical literature makes a strong case for the benefit of individual preconception health components and their effects on adverse pregnancy outcomes. However, the actual effectiveness of collective preconception health in reducing adverse pregnancy outcomes has not yet been demonstrated. In an effort to evaluate the impact of preconception health on maternal morbidity, infant morbidity, and infant mortality, this study will examine the reciprocal relationships between environmental, personal, and preconception behavioral factors and their associations with adverse pregnancy outcomes.

Chapter 3: Methods

Purpose

According to *Healthy People 2010,* about 74% of women obtain early and adequate prenatal care (U.S. Department of Health and Human Services [DHHS], 2000). Yet, prenatal care, even when initiated in early pregnancy, fails to prevent certain fetal development and maternal health risks. Half of all infant deaths are attributed to four causes: 1) congenital malformations/birth defects; 2) disorders related to prematurity and low birth weight (LBW); 3) sudden infant death syndrome (SIDS); and 4) maternal complications of pregnancy (Arias, MacDorman, Strobino, & Guyer, 2003; Bennett & Kotelchuck, 2005). Research indicates that prenatal care alone is insufficient to effect necessary change in these contributors to infant mortality, thus explicating the need for other prevention strategies, such as preconception care (DHHS, 2000; Korenbrot, Steinberg, Bender, & Newberry, 2002). The idea of preconception health derives from ancient times, and it has been addressed in the United States for the last thirty years. Yet, preconception health is only now being considered as an alternative to prenatal care, and its collective effectiveness has not been demonstrated. The literature demonstrates the impact of independent preconception health behaviors on adverse pregnancy outcomes. However, preconception health does not occur in a vacuum. The literature fails to demonstrate the effectiveness of preconception health as a whole on reducing adverse pregnancy outcomes, especially in the context of environmental and personal influences. This study examines the impact of preconception health on adverse pregnancy outcomes through the lens of reciprocal determinism, thereby developing a preconception health conceptual framework that accounts for the

interactive relationships between behavior, the environment, and the person (see Figure 3).

Research Questions

1. What is the relationship between preconception health behaviors and adverse pregnancy outcomes among women of reproductive age?
2. What is the relationship among preconception health behaviors, prenatal factors, postnatal factors, personal influences, environmental factors, and adverse pregnancy outcomes among women of reproductive age?

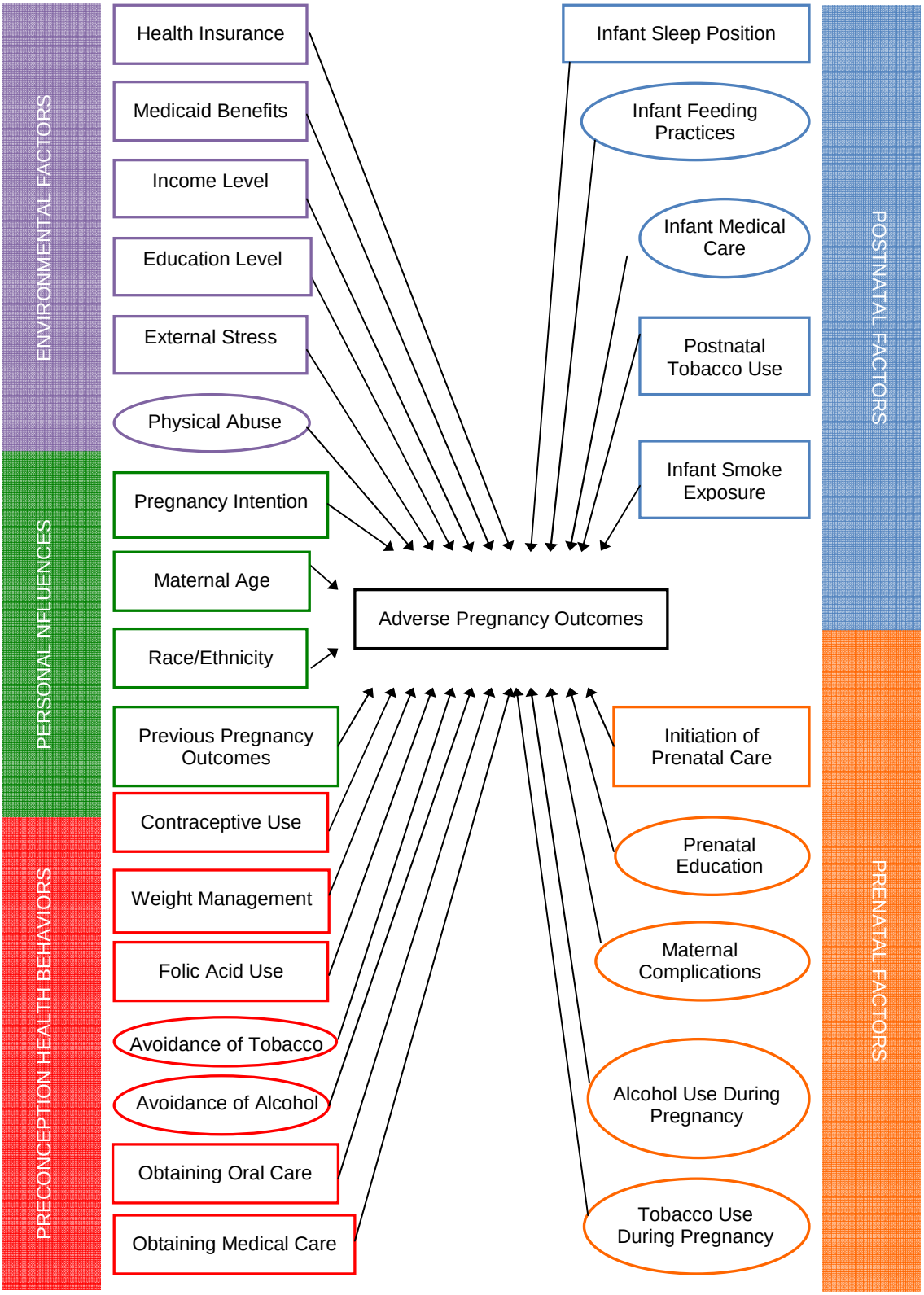
Null Hypotheses

H_O1: Preconception health behaviors are not predictive of adverse pregnancy outcomes.

H_O2: The preconception health framework is not adequate to account for the variance associated with adverse pregnancy outcomes among women of reproductive age.

Study Design

This secondary data analysis employs a non-experimental study design using cross-sectional data collection. The design is appropriate for this study because cross-sectional studies aim to describe the relationship between variables of interest in a specific population at one point in time. Due to the time frame of data collection, cross sectional studies are limited by their inability to examine causal relationships between variables (Kelsey, Whittemore, Evans, & Thompson, 1996).



[Note: Covariance is allowed among all exogenous variables.]

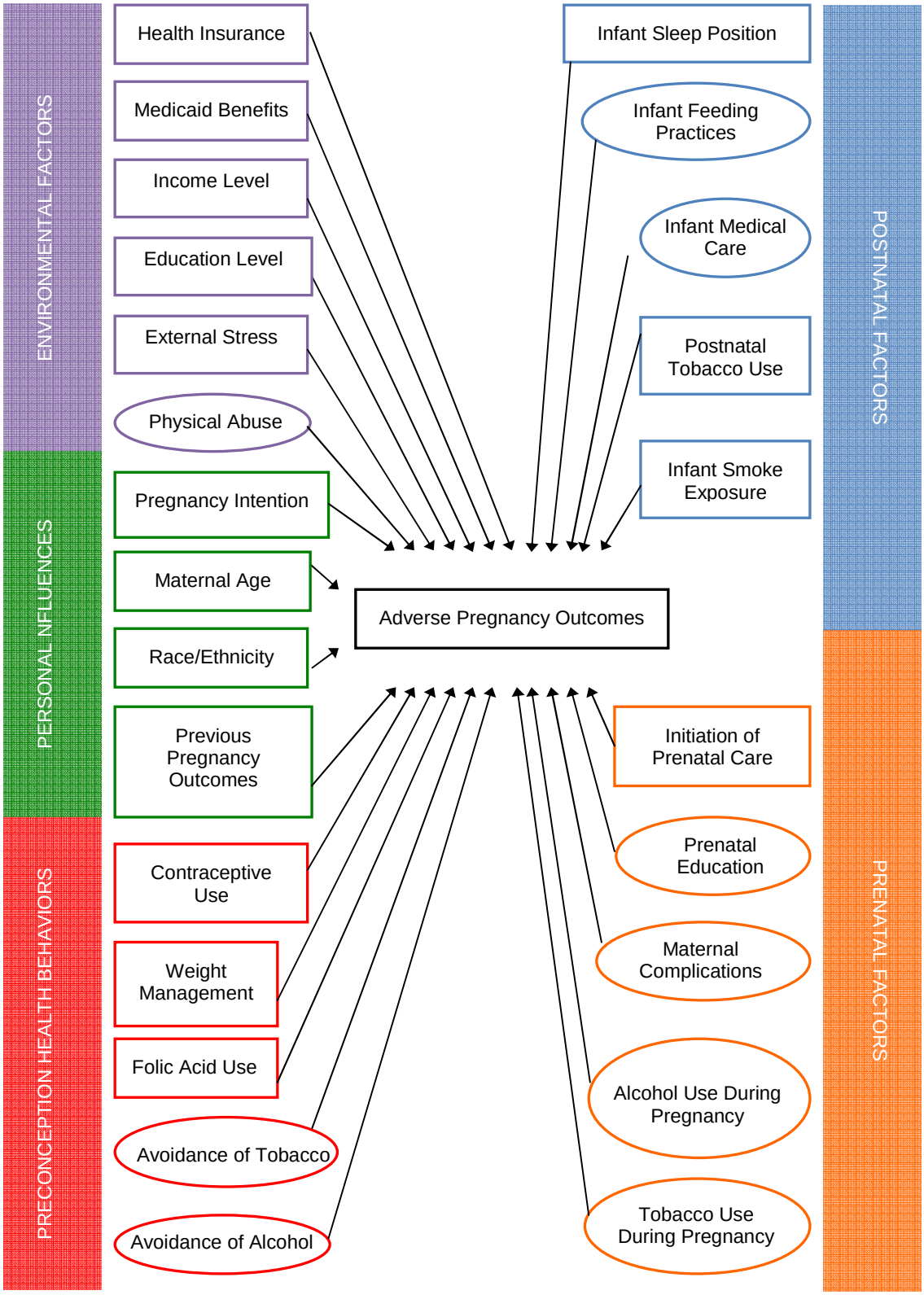
Figure 3. Preconception health framework – Project 1.

Phase five data, collected annually from 2005 to 2008, of the Pregnancy Risk Assessment Monitoring System (PRAMS) surveillance project of the CDC will be used in this analysis. A conceptual framework will be developed and analyzed to address the proposed research questions (Figure 3). For ease of discussion, this framework will be addressed as the preconception health framework. For enhanced generalizability of the study results, the study will be divided into two parts. First, the preconception health framework will be analyzed among the following five states: Maine, New Jersey, Ohio, Utah, and Vermont. These five states are the only PRAMS-participating states that address all of the variables included in the framework. This will be addressed as Project 1. Four of the five states in project one rank among the twelve states with the lowest infant mortality in the nation (Table 3) (Kaiser Family Foundation [KFF], 2009). As infant mortality is an outcome of interest, a second analysis will be conducted with all PRAMS-participating states pending an acceptable fit of the reduced framework based on the fixed parameters of entire framework (Table 3). The reduced framework lacks two constructs eliminated from the framework due to instrumentation limitations: obtaining oral care and obtaining medical care (Figure 4). This will be addressed as Project 2.

Study Sample

In 2006, over four million births occurred in the United States (KFF, 2009). In the same year, 340,352 births were attributed to the five states that will be included in Project 1: Maine, New Jersey, Ohio, Utah, and Vermont (see Table 4) (KFF, 2009). These states, as demonstrated in Tables 3 and 4, are not necessarily representative of all states in relation to race/ethnicity and infant mortality rates. The PRAMS survey aims to target all pregnancies resulting in a live-born infant in the United States with the following exclusions: 1) out-of-state births to residents; 2) in-state births to nonresidents; 3) infants whose birth certificate lacks a maternal last name; 4) those birth certificates processed more than six months after the birth; 5) all but one infant associated with a

multiple gestation; 6) adopted infants; and 7) surrogate births. The sampling frame consists of all mothers that represent the population eligible for study inclusion. Due to inaccessibility of such a sampling frame list, the operational sampling unit consists of all infants born alive within the specified state to resident mothers during a specific time frame, and birth certificates are used as the operational sampling frame, which automatically exclude stillbirths, fetal deaths, and induced abortions. From the remaining eligible birth certificates, a stratified systematic sample of 100 to 250 mothers is drawn every month in each state. States generally oversample for infants with low birth weight, and as the choice for dual stratification variables is limited to birth certificate information, many states opt to stratify by race or ethnicity. Stratification of the sample instills the ability to make inferences about subgroups of public health interest, and it allows for comparisons to be made across groups. A probability sample was surveyed, or in other words, the sample was selected so that within each stratum there was an equal probability of selecting each record. Within each stratum, systematic sampling was employed to select the sample. The sampling fraction ($1/f$), or the probability of selection, was calculated based upon the estimated sampling frame size for the stratum and the desired sample size for that stratum. Then, a number between one and f was chosen at random, that record was selected, and every fth record following was also selected. Sampling for PRAMS surveillance occurs on a monthly basis within two and six months following delivery, although the ideal time frame is two to four months following delivery. The two-month mark is designated to allow for an examination of factors occurring in early infancy, and the four- or six-month mark is designated to minimize recall bias, to increase the probability of locating the mother, and for comparison among respondents. Each participating state samples approximately 1,000 to 3,400 mothers annually.



[Note: Covariance is allowed among all exogenous variables.]

Figure 4. Preconception health framework – Project 2.

Table 3. State rankings according to infant mortality rates (deaths per 1,000 live births), 2003-2005, and current PRAMS participation.

State Ranking (1 = low; 51 = high)	Infant Mortality	PRAMS	State Ranking (continued)	Infant Mortality	PRAMS
1. Minnesota	4.8	*	25. Hawaii	6.7	*
2. Massachusetts	4.9	*	27. Kentucky	6.8	
2. Utah	4.9	*	28. Wyoming	7.0	*
4. New Hampshire	5.0		29. Kansas	7.1	
5. California	5.2	****	30. Florida	7.2	*
6. Iowa	5.4		30. South Dakota	7.2	*
6. New Jersey	5.4	*	32. Pennsylvania	7.3	*
6. Vermont	5.4	*	33. Illinois	7.5	*
6. Washington	5.4	*	33. Virginia	7.5	*
10. Connecticut	5.5		35. Missouri	7.6	*
11. Oregon	5.7	*	36. West Virginia	7.7	
12. Maine	5.9	*	37. Ohio	7.8	*
12. Nebraska	5.9	*	38. Indiana	7.9	****
12. Nevada	5.9		38. Oklahoma	7.9	*
15. New York	6.0	*	40. Maryland	8.0	*
16. Idaho	6.1		40. Michigan	8.0	*
16. New Mexico	6.1	*	42. Arkansas	8.3	*
18. Rhode Island	6.2	*	43. Georgia	8.4	*
19. Colorado	6.3	*	44. North Carolina	8.6	*
19. Wisconsin	6.3	*	45. Tennessee	8.9	*
21. Alaska	6.4	*	46. Alabama	9.0	*
21. Montana	6.4	****	46. Delaware	9.0	*
21. North Dakota	6.4	****	46. South Carolina	9.0	*
21. Texas	6.4	*	49. Louisiana	9.8	*
25. Arizona	6.7		50. Mississippi	10.7	*
			51. Washington D.C.	12.2	****
Note: * = state currently participating in PRAMS; **** = state previously participating in PRAMS					
(Adapted from Kaiser Family Foundation, 2009)					

Table 4. Selected state demographic and birth data characteristics – Project 1.

Selected Characteristics	United States	Maine	New Jersey	Ohio	Utah	Vermont
Number of births, 2006	4,265,555	14,151	115,593	150,593	53,504	6,511
Number of births per 1,000 population	14.2	10.7	13.2	13.1	21.0	10.4
Percentage of live births by race/ethnicity, 2006						
Non-Hispanic White	54.1	94.0	49.5	77.0	78.9	95.2
Non-Hispanic Black	14.5	2.1	15.2	15.8	0.9	1.1
Non-Hispanic Asian/Pacific Islander	5.3	1.6	9.6	2.0	3.0	1.7
Hispanic	24.4	1.5	25.4	4.5	15.4	1.1
Number of infant deaths, 2006	28,527	89	632	1,170	273	36
Infant mortality rate, 2003-2005	6.8	5.9	5.4	7.8	4.9	5.4
Infant mortality rate by race/ethnicity, 2003-2005						
Non-Hispanic White	5.7	5.8	3.7	6.4	4.5	5.3
Non-Hispanic Black	13.6	X	11.9	15.6	X	X
Hispanic	5.6	X	5.2	6.5	5.8	X
Median annual household income, 2005-2007 ($)	49,901	47,160	65,933	47,750	55,974	51,566
Health insurance coverage of nonelderly women, 0-64 (%)						
Medicaid	9.6	17.1	6.5	10.3	6.4	15.5
Uninsured	17.7	9.9	16.8	13.2	16.5	12.2
Percentage of mothers in prenatal care in the first trimester, 2006	83.2	87.7	77.6	72.9	80.2	83.8

(Adapted from Kaiser Family Foundation, 2009)

Analysis weights. Analysis weights are calculated by the CDC for each state to adjust for sample size, nonresponse, and omissions in the sampling frame.

A. Adjustment for sample size: Sampling weight is defined as the reciprocal of the sampling fraction, or selection probability for a particular stratum. For example, if one out of every 100 mothers is sampled, the sampling frame would be 1/100. The reciprocal of the sampling frame would be 100, and each mother in the sample, therefore, represents 100 mothers in the population.

B. Adjustment for nonresponse: When a mother in the sample fails to complete the questionnaire, nonresponse bias may be introduced. To adjust for incompletion, the unit nonresponse weight is calculated. Factors associated with response to PRAMS include maternal age, education, marital status, trimester of first visit to prenatal care, race, Hispanic ethnicity, and unknown birthweight. The unit nonresponse weight is derived as the ratio of the number of sampled mothers in the response category to the number of respondent mothers in the response category.

C. Adjustment for noncoverage: Sometimes mothers may not be included in the sampling frame. Adjustment for such omission is defined as a sampling frame noncoverage weight. Examples of factors associated with noncoverage include stratum, maternal county of residence, and hospital of delivery. This type of weight is computed as the ratio of the number of mothers on the "corrected frame" (sum of original sampling frame and the missed mothers) in the noncoverage category to the number of mothers in the original frame in the noncoverage category.

An analysis weight is subsequently calculated as the product of the sampling weight, the unit nonresponse weight, and the sampling frame noncoverage weight. And, therefore,

the sum of the analysis weights for respondents should equal the number of mothers eligible for PRAMS in the state. These weights are applied by the CDC to state data and will be used in this study.

Sub-analyses. Recall bias may result from an extend time period between the date of the infant's birth and the date of the PRAMS questionnaire completion. A sub-analysis will be conducted to determine the effect of recall bias in the PRAMS population. Also, there may be differences between early and late responders in this study. The statistical weights applied by the CDC account for response differences to some extent. For further analysis, a sub-analysis will be conducted to determine the effect of response waves within the PRAMS population. The CDC does not release these dates for public use (Morrow, B., February 1, 2010). Therefore, the sub-analysis will be conducted via a rough proxy examining the differences between mail and telephone respondents.

Geographic location. Geographic location may influence the incidence of adverse pregnancy outcomes in this study. Only one-half to two-thirds of all PRAMS participating states collect geographic information about respondents (D'Angelo, D.V., December 18, 2009). Each state uses its own algorithm to calculate this information based upon county of residence, and therefore, the degree of interstate consistency is unknown (D'Angelo, D.V., December 18, 2009). This is a limitation of the PRAMS dataset.

Missing data. Through repeated contacts using the modified Dillman method, the CDC attempts to reduce the amount of missing data in PRAMS. When items from the written survey are missing, the item is coded as missing. The survey is not discarded and the item is not imputed. Item non-response varies widely depending on the item, and those items skipped most frequently include height, weight, and dates

(D'Angelo, D.V., December 17, 2009). Even so, this item non-response occurs infrequently, or less than 10% of the time. This is a limitation of the PRAMS dataset.

Sample size. This study will analyze the data using confirmatory factor analysis and path analysis with latent variables, methods used in structural equation modeling (SEM). With regard to sample size in SEM, some references suggest that a sample larger than 100 subjects or five times the number of study variables should be used (Hatcher, 1994). The greatest number of variables used in any model of this study is 24, so the minimum number needed in the sample would be 120. However, other references suggest that models reach stability with larger sample sizes, such as 800 to 1,200 subjects (MacCallum, et al., 1992). These larger sample sizes are recommended for studies in which many model modifications are anticipated (MacCallum, et al., 1992). With data collected over a four-year period with 1,000 to 3,400 subjects annually per state, the minimum number of subjects available for any part of this study will be about 20,000 subjects. This increases the power of the study and exceeds the size limitations associated with structural equation modeling procedures.

Instrumentation. The PRAMS questionnaire was first developed in 1987. The instrument was then edited and revised by the CDC with state participation until April 2004 when the phase five questionnaire was developed that is in use today. PRAMS undergoes continuous assessment and evaluation to revise item material and to meet the public health needs of each state. In the phase five PRAMS questionnaire, there are three types of questions: core questions, standard state questions, state-specific questions. Core questions are used by every participating state. Standard state questions are optional questions of interest for each state that were developed by the CDC with significant state and researcher input. Currently, states may choose from 185 standard questions for their surveys. In addition, states may develop their own specific questions beyond the standard state questions that do not address topics of general

interest. Two types of questionnaires are used with PRAMS surveillance, as discussed previously: a self-administered mail questionnaire or an interviewer-administered telephone questionnaire. Both questionnaire types contain the same research questions, but formatting is slightly altered for ease with telephone use. The questionnaires are available in English and Spanish languages. The range of the number of questions for the PRAMS questionnaire varies per state and per year. On average, each questionnaire contains between 75 and 80 questions (D'Angelo, D.V., December 17, 2009). Since 2000, the shortest survey contained 60 questions and the longest survey contained 90 questions, but these survey lengths are not the norm for PRAMS questionnaires (D'Angelo, D.V., December 17, 2009).

IRB approval. This study involves research with human subjects, but it meets the criteria for Institution Review Board (IRB) exemption. According to exemption category 45 CFR 46.101(b)(4), "Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that participants cannot be identified, directly or through identifiers linked to the participants" (University of South Florida Office of Research, Division of Research Integrity and Compliance, 2008, pp. 4). PRAMS data is publicly available, and the data requested for this study would be de-identified by the CDC prior to data release. Therefore, this study should be acceptable for exemption status by the IRB. An application for IRB exemption will be submitted prior to work with the PRAMS data.

Data acquisition. In previous years, the CDC has provided PRAMS data to individuals through an application proposal process. The application process (CDC, 2008f) includes submission of a four to eight page research proposal from which the CDC PRAMS team will ascertain the suitability of PRAMS data for the proposed analysis and the appropriateness of the analysis plan given the PRAMS survey design. Once

approved, the CDC will send the proposal for state review, and potential state-specific paperwork may follow. Researchers listed on the proposal (in this case, one researcher) will then be required to complete a data sharing agreement form, in which specific guidelines are outlined. These guidelines include statements requiring acknowledgement of the PRAMS Working Group and the CDC for any oral or written presentation. They also state that all oral or written presentation of the study results must be submitted to the CDC and all PRAMS-participating states for review prior to submission for publication or presentation at a meeting. In addition, the guidelines require that all copies of data must be destroyed and confirmed in writing, or returned to the CDC upon completion of the proposed analyses.

Currently, the CDC is in the process of negotiating data sharing agreements with all PRAMS-participating states. There is a hold on the release of data to outside researchers, and completion of this process is projected for January of 2010 (D'Angelo, D.V., July 31, 2009; November 3, 2009). It is possible to contact each state individually to complete each state's application process for obtaining state-level PRAMS data. However, based upon preliminary investigation, it would be difficult to obtain the needed information in a cohesively formatted dataset without cost. Thus, I have come to an arrangement with the CDC to facilitate the implementation of this study (D'Angelo, D.V., November 3, 2009). During the CDC's holding period, each of the five states in Project 1 of this study will be contacted directly to obtain only permission for use of their respective state data. Repeated e-mails, letters, or telephone calls will be made as needed in an attempt to obtain permission from all five states included in Project 1. Once permission is obtained, the CDC will provide the state data pending approval of the CDC's application proposal process. Once the hold is removed, a separate application will be submitted to the CDC to obtain the data required for the analysis of all PRAMS-participating states in Project 2.

Variables and constructs. The variables and constructs of the preconception health framework were directly measured or inferred from birth certificate data and the PRAMS questionnaire. Selected variables from birth certificate data include race/ethnicity, education level, and birth weight (used to designate low birth weight status and to calculate small for gestational age status). Selected variables from the core portion of the PRAMS questionnaire include health insurance status (excluding Medicaid), Medicaid status, income level, external stress, physical abuse, pregnancy intention, maternal age, previous pregnancy outcomes, contraceptive use, folic acid use, avoidance of tobacco, avoidance of alcohol, initiation of prenatal care, prenatal education, maternal complications, alcohol use during pregnancy, tobacco use during pregnancy, infant sleep position, infant feeding practices, infant medical care, postnatal tobacco use, infant smoke exposure, length of maternal hospital stay, preterm delivery, use of the Neonatal Intensive Care Unit (NICU), length of infant hospital stay, and infant mortality. BMI will be calculated from core PRAMS questions ascertaining maternal weight and height, and small for gestational age (SGA) status will be calculated via an algorithm based on birth weight (birth certificate data) and gestational age (PRAMS data). To identify the framework, the measured outcome variable adverse pregnancy outcomes will be defined as a Z-score composite of the following indicator variables: length of maternal hospital stay, preterm delivery, use of the NICU, length of infant hospital stay, and infant mortality. Due to the variability in scale of these variables, Z-scores are used to provide standardization for the composite. In addition, selected variables from standard state questions include obtaining oral care and obtaining medical care, and these variables will be included in Project 1. All of the variables in the preconception framework, and their associated survey items, are identified in Table 5.

To reiterate, in Project 1 of this study, the preconception health framework (Figure 1) will be analyzed for the following five states: Maine, New Jersey, Ohio, Utah, and

Vermont. Four of these five states are among the twelve states with the lowest infant mortality rate. These five states are also not racially and ethnically diverse, so a second set of states will be analyzed, pending acceptable fit of the reduced framework, to evaluate the reliability of the framework in Project 2. However, the state-specific items in the framework (obtaining oral care and obtaining medical care) were not chosen by any other states for survey inclusion and are, therefore, not available for inclusion in Project 2. Thus, Project 2 of this study will rely on core questions only, discarding the state-specific items related to the variables of obtaining oral care and obtaining medical care. The fit of the reduced framework, based on the fixed parameters of the entire framework, will be determined prior to implementation of Project 2. This will determine the effect of the two state-specific items, and whether or not the study should proceed without the inclusion of these variables. Pending an acceptable fit, the framework (Figure 4) will be analyzed among all PRAMS-participating states.

Table 5. Operationalization of the variables of the preconception health framework.

VARIABLE OR CONSTRUCT	#	SURVEY ITEMS AND RESPONSE OPTIONS	SCALE
ENVIRONMENTAL FACTORS			
Income	54	**During the *12 months before* your new baby was born, what was your total household income before taxes?** *(Include your income, your husband's or partner's income, and any other income you may have used.)* A. Less than $10,000 B. $10,000 to $14,999 C. $15,000 to $19,999 D. $20,000 to $24,999 E. $25,000 to $34,999 F. $35,000 to $49,999 G. $50,000 or more	Ordinal

Health Insurance Status	1	***Just before* you got pregnant, did you have health insurance?** *(Do not count Medicaid)* A. No B. Yes	Ordinal
Medicaid Status	2	***Just before* you got pregnant, were you on Medicaid?** A. No B. Yes	Ordinal
Education Level		**From birth certificate data**	Nominal
External Stress	31 31a 31b 31c 31d 31e 31f 31g 31h 31i 31j 31k 31l 31m	**This question is about things that may have happened during the *12 months before* your new baby was born.** *(For each item, circle Yes if it happened to you or circle No if it did not.)* A close family member was very sick and had to go into the hospital. I got separated or divorced from my husband or partner. I moved to a new address. I was homeless. My husband or partner lost his job. I lost my job even though I wanted to go on working. I argued with my husband or partner more than usual. My husband or partner said he didn't want me to be pregnant. I had a lot of bills I couldn't pay. I was in a physical fight. My husband or partner or I went to jail. Someone very close to me had a bad problem with drinking or drugs. Someone very close to me died.	Ordinal

Physical Abuse	32a	**During the *12 months before* you got pregnant, did an ex-husband or ex-partner push, hit, slap, kick, choke, or physically hurt you in any other way?** A. No B. Yes	Ordinal
	32b	**During the *12 months before* you got pregnant, were you physically hurt in any way by your husband or partner?** A. No B. Yes	Ordinal
PERSONAL INFLUENCES			
Pregnancy Intention	10	**Thinking back to *just before* you got pregnant with your *new* baby, how did you feel about becoming pregnant?** A. I wanted to be pregnant sooner B. I wanted to be pregnant later C. I wanted to be pregnant then D. I didn't want to be pregnant then or any time in the future	Nominal
	11	**When you got pregnant with your new baby, were you trying to get pregnant?** A. No B. Yes	Ordinal
Maternal Age	4	**Age derived from the following question:** **What is your date of birth?**	Ratio
Race/Ethnicity		**From birth certificate data**	Nominal
Previous Pregnancy Outcomes	8	**Did the baby born *just before* your new one weight 5 pounds, 8 ounces (2.5 kilos) *or less* at birth?** A. No B. Yes	Ordinal
	9	**Was the baby *just before* your new one born *more* than 3 weeks before its due date?** A. No B. Yes	Ordinal
PRECONCEPTION HEALTH BEHAVIORS			

Contraceptive Use	12	**When you got pregnant with your new baby, were you or your husband or partner doing anything to keep from getting pregnant?** *(Some things people do to keep from getting pregnant include not having sex at certain times [rhythm] or withdrawal, and using birth control methods such as the pill, condoms, cervical ring, IUD, having their tubes tied, or their partner having a vasectomy.)* A. No B. Yes	Ordinal
Weight Management	 5 6	**BMI derived from the following questions:** ***Just before* you got pregnant with your new baby, how much did you weigh?** **How tall are you without shoes?**	Interval
Folic Acid Use	3	**During the *month before* you got pregnant with your new baby, how many times a week did you take a multivitamin or a prenatal vitamin?** *(These are pills that contain many different vitamins and minerals.)* A. I didn't take a multivitamin or a prenatal vitamin at all. B. 1 to 3 times a week C. 4 to 6 times a week D. Every day of the week	Ordinal
Avoidance of Tobacco	24 25	**Have you smoked at least 100 cigarettes in the *past 2 years*?** *(A pack has 20 cigarettes.)* A. No (skip 25) B. Yes **In the *3 months before* you got pregnant, how many cigarettes did you smoke on an average day?** *(A pack has 20 cigarettes.)* A. 41 cigarettes or more B. 21 to 40 cigarettes C. 11 to 20 cigarettes D. 6 to 10 cigarettes E. 1 to 5 cigarettes F. Less than 1 cigarette G. None (0 cigarettes)	Ordinal Ordinal
Avoidance of Alcohol	28	**Have you had any alcoholic drinks in the *past 2 years*?** *(A drink is 1 glass of wine, wine cooler, can or bottle of beer, shot of liquor, or mixed drink.)*	Ordinal

		A. No (skip 29a and 29b) B. Yes	
	29a	**During the *3 months before* you got pregnant, how many alcoholic drinks did you have in an average week?** A. 14 drinks or more a week B. 7 to 13 drinks a week C. 4 to 6 drinks a week D. 1 to 3 drinks a week E. Less than 1 drink a week F. I didn't drink then	Ordinal
	29b	**During the *3 months before* you got pregnant, how many times did you drink 5 alcoholic drinks or more in one sitting?** A. 6 or more times B. 4 to 5 times C. 2 to 3 times D. 1 time E. I didn't have 5 drinks or more in 1 sitting F. I didn't drink then	Ordinal
Obtaining Oral Care	Y3a	**When did you have your teeth cleaned by a dentist or dental hygienist?** **a. Before my most recent pregnancy** i. No ii. Yes	Ordinal
Obtaining Medical Care	L17	***Before* you got pregnant with your new baby, did you talk with a doctor, nurse, or other health care worker to prepare for a healthy pregnancy and baby?** A. No B. Yes	Ordinal
POSTNATAL FACTORS			
Infant Sleep Position	48	**How do you *most often* lay your baby down to sleep now?** A. On his or her side B. On his or her back C. On his or her stomach	Nominal
Infant Feeding Practices	43	**Did you ever breastfeed or pump breast milk to feed your new baby after delivery?** A. No (skip to #47) B. Yes	Ordinal
	44	**Are you still breastfeeding or feeding pumped**	Ordinal

		milk to your new baby? A. No B. Yes (skip to #46)	
	45	**How many weeks or months did you breastfeed or pump milk to feed your baby?** A. [ ] Weeks B. [ ] Months C. Less than 1 week	Ratio
	46	**How old was your baby the first time you fed him or her anything besides breast milk?** **(***Include formula, baby food, juice, cow's milk, water, sugar water, or anything else you fed your baby).* A. [ ] Weeks B. [ ] Months C. My baby was less than 1 week old D. I have not fed my baby anything besides breast milk	Ratio
Infant Medical Care	49	**Was your new baby seen by a doctor, nurse, or other health care worker during the first week after he or she left the hospital?** A. No B. Yes	Ordinal
	50	**Has your new baby had a well-baby checkup?** (*A well-baby checkup is a regular health visit for your baby usually at 2, 4, or 6 months of age).* A. No B. Yes	Ordinal
Postnatal Tobacco Use	27	**How many cigarettes do you smoke on an average day *now*?** *(A pack has 20 cigarettes.)* A. 41 cigarettes or more B. 21 to 40 cigarettes C. 11 to 20 cigarettes D. 6 to 10 cigarettes E. 1 to 5 cigarettes F. Less than 1 cigarette G. None (0 cigarettes)	Ordinal
Infant Smoke Exposure	47	**About how many hours a day, on average, is your new baby in the same room with someone who is smoking?** A. [ ] Hours B. Less than 1 hour a day C. My baby is never in the same room with someone who is smoking	Ratio

PRENATAL FACTORS			
Initiation of Prenatal Care	15	**How many weeks or months pregnant were you when you had your first visit for prenatal care?** *(Do not count a visit that was only for a pregnancy test or only for WIC [the Special Supplemental Nutrition Program for Women, Infants, and Children].)* A. [ ] Weeks [ ] Months B. I didn't go for prenatal care	Ratio
Prenatal Education	19	**During any of your prenatal care visits, did a doctor, nurse, or other health care worker talk with you about any of the things listed below?** *(Please count only discussions, not reading materials or videos. For each item, circle **Y** [Yes] if someone talked with you about it or circle **N** [No] if no one talked with you about it.)*	Ordinal
	19a	How smoking during pregnancy could affect my baby.	
	19c	How drinking alcohol during pregnancy could affect my baby.	
	19d	Using a seat belt during my pregnancy.	
	19e	Birth control methods to use after my pregnancy.	
	19f	Medicines that are safe to take during my pregnancy.	
	19g	How using illegal drugs could affect my baby.	
	19h	Doing tests to screen for birth defects or diseases that run in my family.	
	19i	What to do if my labor starts early.	
	19j	Getting tested for HIV (the virus that causes AIDS).	
	19k	Physical abuse to women by their husbands or partners.	
Maternal Complications	22	**Did you have any of these problems during your most recent pregnancy?** *(For each item, circle **Y** [Yes] if you had the problem or circle **N** [No] if you did not.)*	Ordinal

	22b	High blood sugar (diabetes) that started *during* this pregnancy.	
	22c	Vaginal bleeding.	
	22d	Kidney or bladder (urinary tract) infection.	
	22e	Severe nausea, vomiting, or dehydration.	
	22f	Cervix had to be sewn shut (incompetent cervix).	
	22g	High blood pressure, hypertension (including pregnancy-induced hypertension [PIH], preeclampsia, or toxemia).	
	22h	Problems with the placenta (such as abruptio placentae or placenta previa).	
	22i	Labor pains more than 3 weeks before my baby was due (preterm or early labor).	
	22j	Water broke more than 3 weeks before my baby was due (premature rupture of membranes [PROM]).	
	22k	I had to have a blood transfusion.	
Alcohol Use During Pregnancy	28	**Have you had any alcoholic drinks in the *past 2 years*?** *(A drink is 1 glass of wine, wine cooler, can or bottle of beer, shot of liquor, or mixed drink.)* A. No (skip 30a and 30b) B. Yes	Ordinal
	30a	**During the *last 3 months* of your pregnancy, how many alcoholic drinks did you have in an average week?** A. 14 drinks or more a week B. 7 to 13 drinks a week C. 4 to 6 drinks a week D. 1 to 3 drinks a week E. Less than 1 drink a week F. I didn't drink then	Ordinal
	30b	**During the *last 3 months* of your pregnancy, how many times did you drink 5 alcoholic drinks or more in one sitting?** A. 6 or more times B. 4 to 5 times C. 2 to 3 times D. 1 time E. I didn't have 5 drinks or more in 1 sitting F. I didn't drink then	Ordinal

Tobacco Use During Pregnancy	24 26	**Have you smoked at least 100 cigarettes in the *past 2 years*?** *(A pack has 20 cigarettes.)* A. No (skip 26) B. Yes **In the *last 3 months* of your pregnancy, how many cigarettes did you smoke on an average day?** *(A pack has 20 cigarettes.)* A. 41 cigarettes or more B. 21 to 40 cigarettes C. 11 to 20 cigarettes D. 6 to 10 cigarettes E. 1 to 5 cigarettes F. Less than 1 cigarette G. None (0 cigarettes)	Ordinal Ordinal
ADVERSE PREGNANCY OUTCOMES			
		Maternal Morbidity	
Length of Maternal Hospital Stay	 35 37	**Length of Hospital Stay derived from the following questions:** **When did you go into the hospital to have your baby?** A. [ ] Month Day Year B. I didn't have my baby in a hospital **When were you discharged from the hospital after your baby was born?** (It may help to use the calendar) A. [ ] Month Day Year B. I didn't have my baby in a hospital	Ratio
		Infant Morbidity	
Preterm Delivery	 34 36	**Preterm Delivery derived from the following questions:** **When was your baby due?** [ ] Month Day Year **When was your baby born?** [ ] Month Day Year	Ratio
Low Birth Weight		**Low Birth Weight: derived from birth certificate data**	Ratio

Small for Gestational Age		**Small for Gestational Age: derived via an algorithm based upon birth weight and gestational age**	Interval
Use of NICU	39	**After your baby was born, was he or she put in an intensive care unit?** A. No B. Yes C. I don't know	Ordinal
Length of Infant Hospital Stay	40	**After your baby was born, how long did he or she stay in the hospital?** A. Less than 24 hours (less than 1 day) B. 24 to 48 hours (1 to 2 days) C. 3 days D. 4 days E. 5 days F. 6 days or more G. My baby was not born in a hospital H. My baby is still in the hospital	Ordinal
		Infant Mortality	
Infant Mortality	41	**Is your baby alive now?** A. No B. Yes	Ordinal

Scales of measurement. This study includes variables of all levels of measurement: nominal, ordinal, interval, and ratio-level variables. The nominal variables, race/ethnicity, pregnancy intention, and infant sleep position (item 10) will be dummy coded for analysis purposes. Maternal age, initiation of prenatal care, infant feeding practices, and infant smoke exposure are ratio-level variables, as are the items associated with preterm delivery, low birth weight, and length of maternal hospital stay. Gestational age will be collapsed to an ordinal level item, and preterm delivery will be categorized as a gestational age of 37 weeks or less. Birth weight will be collapsed into an ordinal level item, and low birth weight will be categorized as a birth weight of 2,500

grams (5 pounds, 8 ounces) or less; very low birth weight as 1,500 grams (3 pounds, 5 ounces) or less; and extreme low birth weight as less than 1,000 grams (2 pounds, 3 ounces). Maternal and infant hospital stay items will be collapsed into ordinal level items. The average length of infant hospitalization in both regular and cesarean deliveries resulting in birth trauma is 3 days (Nair, 2007). Excessive infant length of hospital stay will be categorized as a length of stay of 4 days or more. Regarding maternal length of hospital stay, most federal and state legislation requires insurance plans to cover postpartum hospital stays of ≥48 hours for vaginal deliveries and ≥72 or 96 hours for cesarean sections (Datar & Sood, 2006; Liu, Dow, & Norton, 2004). Cesarean section is considered a complication of the delivery process, and therefore, a type of maternal morbidity (Danel, Berg, Johnson, & Atrash, 2003). Thus, the length of hospital stay due to cesarean section will not represent the upper limit in this case (Danel, Berg, Johnson, & Atrash, 2003). Excessive maternal length of hospital stay will be categorized as a length of stay of 4 days or more. Body Mass Index (BMI), a proxy for the interval-level weight management variable, will be calculated based upon participants' reported weight and height. Then, to accommodate the nonlinear parabolic curve attributed to BMI, a standard score will be developed. A standard score indicates how many standard deviations a particular result is above or below the mean. All remaining variables are ordinal-level or categorical variables.

Data Analysis

Both Projects 1 and 2 will be separately analyzed, pending acceptable fit of the reduced model based on the fixed parameters of the entire framework, using the following analysis plan. For cross-validation purposes, the datasets associated with Project 1 and Project 2 will each be randomly divided into two subsamples prior to analysis. Subsample A will be used as a calibration sample to build and test the proposed framework, and Subsample B will be used as the validation sample to only test

the proposed framework (Cudeck & Browne, 1983). Replication of the study accomplished via cross-validation estimates the generalized performance of a predictive model, and both samples in this study are large enough to utilize this type of cross-validation procedure (Cudeck & Browne, 1983).

Data analyses will be performed for each project of this study, including univariate procedures, bivariate procedures, confirmatory factor analysis, and structural equation modeling. Univariate data analysis will be performed to determine the frequency and descriptive statistics of all exogenous variables. Bivariate correlations will be performed to determine associations between all variables, which may influence the selection of variables for further analyses.

Answers to the proposed research questions for this study will be ascertained through the use of structural equation modeling. Structural equation modeling (SEM), or path analysis, is a multivariate statistical method often used to test theoretical models and the underlying relationships that lie therein (Hatcher, 1994). SEM provides an outlook on whether the model fits the data, as a whole, and then it examines significance tests for any causal relationships specified (Hatcher, 1994). If there is a poor fit between the model and the data, the model may be modified to improve the fit (Hatcher, 1994). The reference to causal relationships is not entirely accurate for all SEM analyses, as the conditions of causality must be met in the study regardless of the use of SEM. These conditions include an association between the variables thought to exhibit cause-and-effect (constant conjunction), a temporal ordering between the variables (the cause precedes the effect, antecedence), and ruling out alternative explanations (necessary conjunction) (Slife & Williams, 1995). This study is a cross-sectional design, and thus, causality cannot be determined due to a lack of temporal ordering.

SEM is achieving wider recognition in the social sciences. SEM and regression methods exhibit similar characteristics, as both are part of the general linear model family (Buhi,

Goodson, & Neilands, 2007). Both methods assess linear combinations of variables, maximize explained variance and minimize model error variance through the use of weights, use latent variables (underlying variables not directly observed), and produce effect sizes which account for variance (Buhi, Goodson, & Neilands, 2007). According to Buhi and colleagues, when compared to other multivariate methods of analysis, SEM has several advantages: 1) the relationships between multiple independent and dependent variables may be evaluated in part or as a whole; 2) the ability to test hypotheses across several variables at once controls for inflations in experimentwise, or Type 1, error; 3) SEM allows for the testing of theory-driven models with empirical data; 4) SEM examines relationships among latent variables with multiple observed variables reducing measurement error; and 5) SEM software provides advanced solutions for the treatment of missing data, such as optimal full information maximum likelihood (FIML) (Wothke, 2000; Arbuckle, 1996). In addition, SEM is useful method to comprehensively test and develop theoretical models (Anderson & Gerbing, 1988).

A comprehensive two-step approach to modeling allows the researcher to make meaningful inferences about constructs and their relationships while avoiding false inferences (Anderson & Gerbing, 1988). The following two-step modeling approach is recommended for structural equation modeling (Kline, 1998; Hatcher, 1994).

First, in Subsample A only, a measurement model will be developed and validated through the use of confirmatory factor analysis to determine item retention (Anderson & Gerbing, 1988). A measurement model describes the relationships between latent constructs and their associated indicator variables (Hatcher, 1994; Anderson & Gerbing, 1988). Indicator variables must demonstrate a high level of convergent validity, or in other words, they must all be clearly measuring the same underlying construct (Hatcher, 1994). Model fit measures the extent to which the predicted covariances in the model

compare to observed covariances in the data, which is equivalent to diminishing the type II error (Garson, 2009).

There is no general agreement on preferred measures of fit, and therefore, different fit indices are reported for different research studies (Maruyama, 1998). The use of several fit indices is recommended for triangulation (Klem, 2000). Measures of fit may be assessed through the use of many fit indices, including among others the chi-square statistic, the non-normed fit index (NNFI), the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR) (Klem, 2000). With assumptions of a large sample size and multivariate normal distribution met, the chi-square test is a generally recognized fit index to test the null hypothesis that the model fits the observed data (Henson, 1999; Hu & Bentler, 1995). Good overall fit of a model is generally determined by a relatively small chi-square value with a corresponding p-value close to one (Hatcher, 1994). However, large samples typically indicate a significant chi-square statistic even when there is good model fit (James, et al., 1982). Thus, a relatively small chi-square value depends upon the degrees of freedom associated with the analysis (Hatcher, 1994). Researchers often accept the rule of thumb that the chi-square/degrees of freedom ratio should be less than two, but this is somewhat arbitrary and should be used with caution (Hatcher, 1994). Due to the categorical nature of the indicator variables in this study, maximum likelihood estimation or weighted least squares estimation is recommended (M-*plus,* 2009). To supplement the findings of the chi-square statistic, the non-normed fit index (NNFI), the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR) will also be analyzed. The NNFI (Bentler & Bonett, 1980) and the CFI (Bentler, 1989) are recommended as overall goodness of fit indices, and a value over 0.9 indicates acceptable model fit (Hatcher, 1994). The RMSEA is less affected by sample size than

the chi-square statistic, and therefore, has more descriptive value across various sample sizes (Meyers, Garnst, & Guarino, 2006). According to Byrne, RMSEA cut-off values less than 0.08 are deemed acceptable and values greater than 0.10 are generally deemed unacceptable (Byrne, 1998). With SRMR, a smaller value indicates better model fit, and a value of less than 0.08 is considered good fit (Hu & Bentler, 1998). R^2 values will also be evaluated to determine the extent to which the independent variables account for the variability in adverse pregnancy outcomes (Hatcher, 1994). R^2 values range from zero to one, with higher values indicating a larger percent of variance accounted for (Hatcher, 1994). Also, in a model with good fit, the absolute values of the normalized residual matrix should not exceed 2.0, the absolute value of the *t* statistics for each path coefficient should exceed 1.96, and the absolute value of standardized path coefficients should exceed 0.05 (Hatcher, 1994). An acceptable model fit does not have to display all of these characteristics, but meeting more fit characteristics yields a greater degree of confidence in the model (Hatcher, 1994).

In the measurement model assessment, triangulation of measures of fit provides an evidentiary basis to determine the need for model modification (Hatcher, 1994). Modification indices may suggest ways to improve the fit of the model, and nonsignificant factor loadings may be examined for possible removal from the model (Hatcher, 1994). The measurement model is therefore modified until it displays an acceptable fit to the data. Any modified models will also be subjected to an analysis of overall model fit.

Second, the structural model is tested, in this case using path analysis with latent variables (Hatcher, 1994; Anderson & Gerbing, 1988). The structural model will be tested in both Subsamples A and B. The structural model determines if the model, as a whole, demonstrates an acceptable fit to the data (Hatcher, 1994; Anderson & Gerbing, 1988). Thus, the structural model demonstrates the predicted associations between the

constructs of theoretical interest (Hatcher, 1994).

After the measurement model demonstrates acceptable fit, a framework variation will be examined in both Projects 1 and 2 to assess the first proposed research question (see Table 6, Figure 5 for Project 1 and Table 7, Figure 6 for Project 2). The path coefficients will be analyzed to determine the strength of associations between exogenous variables and adverse pregnancy outcomes. The R^2 values will be analyzed to determine the extent to which these groups of exogenous variables account for the variability in adverse pregnancy outcomes. The proposed preconception health framework (Project 1) and the reduced preconception health framework (Project 2) will be subjected to the aforementioned measures of fit to assess how well they fit the sample data.

Statistical software. Upon receipt of the data from the individual states, Statistical Analysis Software (SAS) will be used to combine the individual state datasets, dummy code variables, to calculate Z-scores, to calculate standard scores, and to calculate the formula variables, such as BMI and SGA. M-*plus* statistical software will then be used to conduct the structural equation modeling procedures. This software is capable of handling numerous dichotomous categorical variables, and it is also capable of handling the types of complex analysis or sampling weights used with PRAMS data (M-*plus,* 2009).

Plans for Dissemination

This study will be submitted for publication in the American Journal of Public Health and the American Journal of Obstetricians and Gynecologists. These results will also be submitted for the MCH Section of the APHA convention and for the National Summit on Preconception Health and Health Care.

Table 6. Research question-specific analyses – Project 1.

Research Questions	Source of Data	Type of Statistical Analysis
1. What is the relationship between preconception health behaviors and adverse pregnancy outcomes among women of reproductive age?		Confirmatory Factor Analysis --- SEM
A. To what extent do preconception health behaviors explain the variance associated with adverse pregnancy outcomes? B. Which preconception health behaviors are most strongly associated with adverse pregnancy outcomes?	**Preconception behaviors** PRAMS Core Items: 3, 5, 6, 12, 24, 25, 28-29b Standard State Items: Y3a, L17 **Adverse pregnancy outcomes** PRAMS Core Items: 34-37, 39-41 Birth certificate data: LBW, SGA	Figure 5
2. What is the relationship among preconception health behaviors, prenatal factors, postnatal factors, personal influences, environmental factors, and adverse pregnancy outcomes among women of reproductive age?		Confirmatory Factor Analyses --- SEM
A. To what extent does the entire conceptual framework account for the variance associated with adverse pregnancy outcomes? B. Which factors are most strongly associated with adverse pregnancy outcomes?	**Preconception behaviors** PRAMS Core Items: 3, 5, 6, 12, 24, 25, 28-29b Standard State Items: Y3a, L17 **Prenatal factors** PRAMS Core Items: 15, 19a,c-k, 22b-k, 24, 26, 28, 30a-b **Postnatal factors** PRAMS Core Items: 27, 43-50 **Environmental factors** PRAMS Core Items: 1, 2, 31, 32, 54	Figure 3 (full framework)

	Birth certificate data: Education
	Personal Influences
	PRAMS Core Items: 4, 8-11
	Birth certificate data:
	Race/Ethnicity
	Adverse Pregnancy Outcomes
	PRAMS Core Items: 34-37, 39-41
	Birth certificate data: LBW, SGA

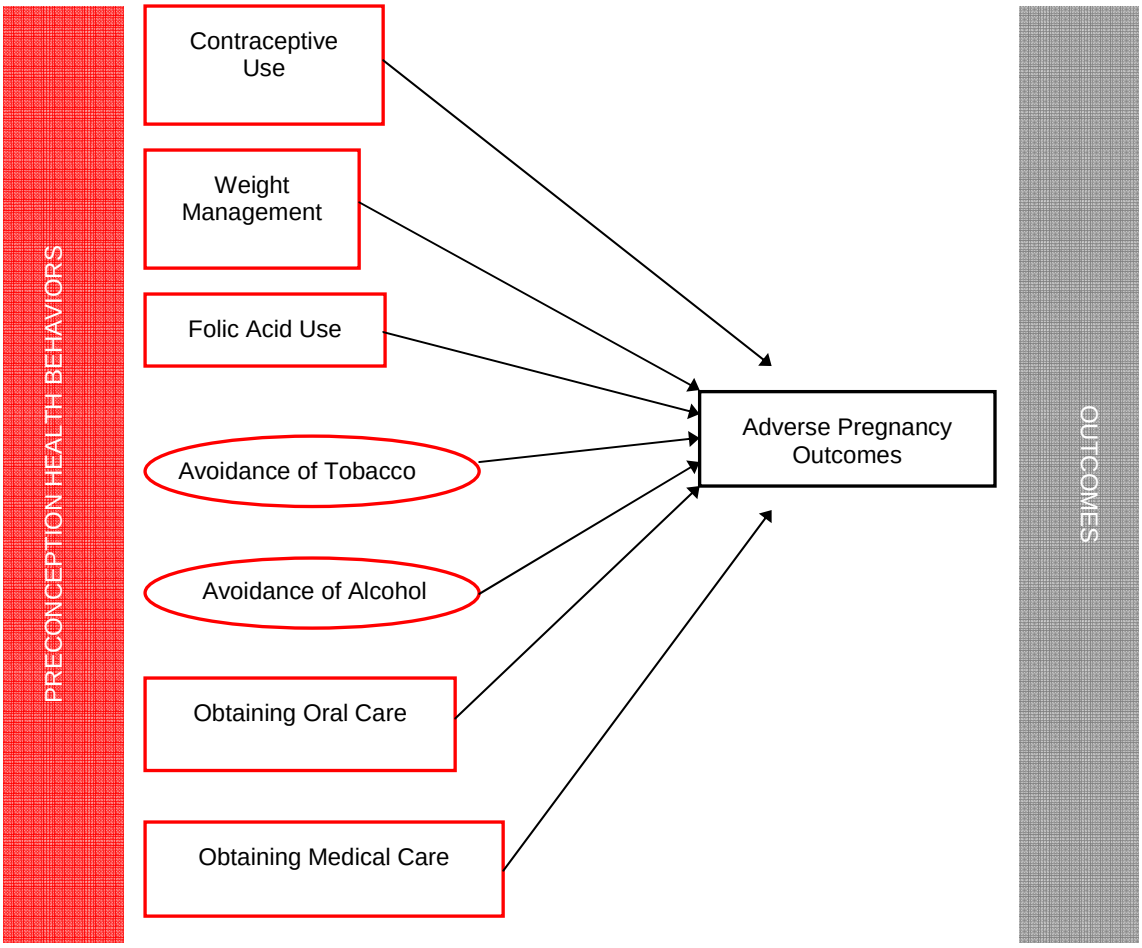


Figure 5. Conceptual framework for research questions 1A and 1B – Project 1.

Table 7. Research question-specific analyses – Project 2.

Research Questions	Source of Data	Type of Statistical Analysis
1. What is the relationship between preconception health behaviors and adverse pregnancy outcomes among women of reproductive age?		Confirmatory Factor Analysis --- SEM
C. To what extent do preconception health behaviors explain the variance associated with adverse pregnancy outcomes? D. Which preconception health behaviors are most strongly associated with adverse pregnancy outcomes?	**Preconception behaviors** PRAMS Core Items: 3, 5, 6, 12, 24, 25, 28-29b **Adverse pregnancy outcomes** PRAMS Core Items: 34-37, 39-41 Birth certificate data: LBW, SGA	Figure 6
2. What is the relationship among preconception health behaviors, prenatal factors, postnatal factors, personal influences, environmental factors, and adverse pregnancy outcomes among women of reproductive age?		Confirmatory Factor Analyses --- SEM
C. To what extent does the entire conceptual framework account for the variance associated with adverse pregnancy outcomes? D. Which factors are most strongly associated with adverse pregnancy outcomes?	**Preconception behaviors** PRAMS Core Items: 3, 5, 6, 12, 24, 25, 28-29b **Prenatal factors** PRAMS Core Items: 15, 19a,c-k, 22b-k, 24, 26, 28, 30a-b **Postnatal factors** PRAMS Core Items: 27, 43-50 **Environmental factors** PRAMS Core Items: 1, 2, 31, 32, 54 Birth certificate data: Education	Figure 4 (full framework)

	Personal Influences PRAMS Core Items: 4, 8-11 Birth certificate data: Race/Ethnicity **Adverse Pregnancy Outcomes** PRAMS Core Items: 34-37, 39-41 Birth certificate data: LBW, SGA

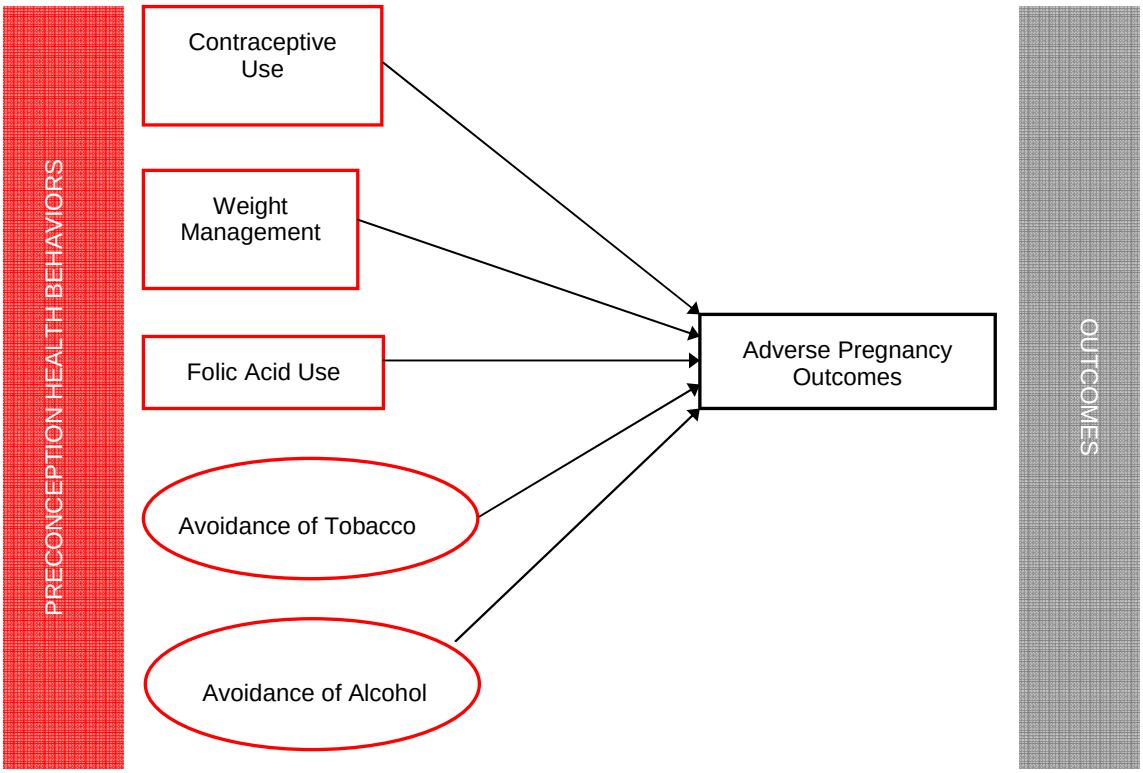


Figure 6. Conceptual framework for research questions 1A and 1B – Project 2.

Chapter 4: Results

Brief Overview

The purpose of this study was to examine the impact of preconception health on adverse pregnancy outcomes through the theoretical lens of reciprocal determinism. A non-experimental study in nature, this study involved an analysis of Pregnancy Risk Assessment Monitoring System (PRAMS) data, a cross-sectional survey designed and implemented by each participating state under the guidelines of the Centers for Disease Control and Prevention. The aim was to develop a preconception health conceptual framework to account for the interactive relationships among behavior, environment, and the person. The intention of the design was to answer the following research questions:

1. What is the relationship between preconception health behaviors and adverse pregnancy outcomes among women of reproductive age?
    a. To what extent do preconception health behaviors explain the variance associated with adverse pregnancy outcomes?
    b. Which factors are most strongly associated with adverse pregnancy outcomes?
2. What is the relationship among preconception health behaviors, prenatal factors, postnatal factors, personal influences, environmental factors, and adverse pregnancy outcomes among women of reproductive age?
    a. To what extent does the entire framework explain the variance associated with adverse pregnancy outcomes?
    b. Which factors are most strongly associated with adverse pregnancy outcomes?

This chapter summarizes some changes made to the original plan of analysis (Chapter 3 – METHODS) because of characteristics associated with the datasets. It also summarizes the results of this study including descriptive statistics, factor correlations, confirmatory factor analysis, and structural equation modeling conducted to examine the preconception health framework. It is important to note that an issue with the postnatal variables in the framework. Of the 431 women whose baby died in Project 1 and of the 3,998 women whose baby died in Project 2, no one answered five of the six postnatal variables: infant smoke exposure, infant medical care within the first week after birth, well-baby check-ups, breastfeeding duration, and infant sleep position. Postnatal maternal smoking was an exception to this lack of information with 133 and 1,142 responses, respectively. With a lack of information available for this population regarding these variables, data were not imputed due to the possibility of introducing bias. Therefore postnatal variables were excluded from the following analyses.

Study population. As requested, the PRAMS dataset for Project 1 obtained from the Centers for Disease Control and Prevention (CDC) contained data from five states: Maine, New Jersey, Ohio, Utah, and Vermont. Vermont was removed from the analysis due to its automatic exclusion of the maternal race and Hispanic ethnicity variables as possible identifiers of their PRAMS population. Of the four remaining states associated with Project 1, the first PRAMS dataset included 27,933 participants. The PRAMS dataset for Project 2 contained data from all PRAMS participating states from 2005-2008, with the exception of Vermont (32 states and one city – refer to Table 8). Of the states associated with Project 2, the second PRAMS dataset included 200,008 participants.

Missing data. Data were imputed for variables associated with skip patterns in the PRAMS questionnaire. In one case, an item concerning alcohol consumption in the last two years was followed by questions regarding the frequency of alcohol

consumption and the occurrence of binge drinking in the preconception and prenatal periods. If a woman did not consume alcohol in the last two years, the appropriate response would be: "I didn't drink then." She would then skip the next two alcohol-related questions. Based upon this skip pattern, missing data in the two alcohol-related

Table 8. List of all PRAMS participating states 2005-2008 included in Project 2.

Alaska	Michigan *	Rhode Island
Arkansas *	Minnesota	South Carolina *
Colorado	Missouri	Tennessee *
Delaware *	Mississippi *	Utah
Florida	North Carolina *	Washington
Georgia *	Nebraska	Wisconsin
Hawaii	New Jersey	West Virginia
Illinois	New Mexico	Wyoming
Louisiana *	New York	
Massachusetts	Ohio	New York City
Maryland *	Oklahoma	
Maine	Oregon	

Note: * = Among the ten states with the highest infant mortality rates, 2003-2005

items were re-coded as: "I didn't drink then." Similarly, an item concerning smoking in the last two years was followed by the average number of cigarettes per day in the preconception, prenatal, and postnatal periods, respectively. If a woman did not smoke in the last two years, the appropriate response would be: "None (zero cigarettes)." She would then skip the next tobacco-related questions. Based upon this skip pattern, missing data in the tobacco-related items were re-coded as: "None (zero cigarettes)." An examination of the randomness of missing data was conducted, and the contraceptive use variable and the oral health care variable were found to be the variables with the largest amount of missing data (53% and 39%, respectively). The contraceptive use variable was, therefore, excluded from the analysis, and the oral health care variable was included in the analysis due to its pertinence to the framework, its uniqueness to Project 1, and its lower percentage of missing data.

Remaining missing data were removed by list-wise deletion. In Project 1, this action resulted in a decrease from the original 27,933 participants to 12,239 participants. In Project 2, this action resulted in a decrease from the original 200,008 participants to 128,551 participants. The demographic characteristics of the participants deleted from each sample are presented throughout the chapter as applicable.

Variable modifications. Upon receipt of the first PRAMS dataset, a few changes were made to the framework and to the calculation of composite variables. An examination of the redundancy and pertinence of the four postnatal breastfeeding variables resulted in a reduction to one variable, duration of breastfeeding. In addition, the adverse pregnancy outcomes and the maternal BMI variables were calculated differently than the z-score compilations originally planned. The adverse pregnancy outcomes variable derives from the following variables (cutoffs based upon empirical literature): use of the NICU, length of infant hospital stay (4 days or more), length of maternal hospital stay (4 days or more), low birth weight (2,500 grams or less), preterm delivery (259 days [37 weeks] or less), small for gestational age, and infant mortality. These variables were re-coded so the pertinent adverse pregnancy outcome would be equal to one with all other values equal to zero. For example, a participant with a 1,578-gram neonate would be assigned a "1" for the GRAM variable, whereas a participant with a 2,620-gram neonate would be assigned a "0" for the same variable. The adverse pregnancy outcomes were then summed for each participant, resulting in a maximum adverse pregnancy outcomes value of "7" (experienced all adverse pregnancy outcomes) or a minimum value of "0" (experienced no adverse pregnancy outcomes). The adverse pregnancy outcomes variable was subsequently treated as a continuous variable. To split the maternal BMI variable into underweight and overweight variables, two new vectors were created indicating the presence of underweight BMI (less than 18.5 BMI, represented as the value of "1") or the presence of overweight BMI (25.0 BMI

or higher, represented as the value of “1”). Then, the new vectors were multiplied by the original maternal BMI variable, and the resulting new variables contained the underweight or overweight BMIs respectively. Another variable modification involved the dummy coding of four nominal variables: 1) maternal race [reference group = white]; 2) pregnancy intention – timing [reference group = wanted to be pregnant then]; 3) pregnancy history [previous live birth was neither low birth weight nor preterm]; and 4) sleep position [side only]. In addition, the variables related to tobacco use (prior to pregnancy, during pregnancy, and after delivery), alcohol use (prior to pregnancy and during pregnancy; frequency and binge drinking), and abuse (before and during pregnancy) were reverse coded for ease in interpretation. The variables associated with prenatal education and maternal complications were grouped as well. The ten “Talk” variables were re-coded to equal “1” if the topic was discussed with a health care provider. The talk variables were then summed for each participant represented as prenatal education. Thus, the prenatal education variable ranged from a maximum value of 10 (discussed all listed topics with a health care provider) to a minimum value of 0 (did not discuss any listed topics with a health care provider). The ten maternal complication variables also were re-coded to equal “1” if the complication was experienced. The complication variables were then summed for each participant represented as maternal complications. Thus, the maternal complications variable ranged from a maximum value of 10 (experienced all listed complications) to a minimum value of 0 (did not experience any of the listed complications).

Confirmatory Factor Analysis

Descriptive statistics. The sample was split into two random groups, one group containing 6,120 participants (Subsample A) and the other group containing 6,119 participants (Subsample B). Subsample A, a calibration sample, was designed to build and test the proposed framework; Subsample B, a validation sample, was designed

merely to test the framework. The demographic characteristics of each random sample are shown in Table 9.

Table 9. Demographic characteristics of two random samples in Project 1.

PROJECT 1	SAMPLE A (N=6,120)			SAMPLE B (N=6,119)		
	Freq.	Weighted Frequency	Percent	Freq.	Weighted Frequency	Percent
AGE						
17 years of age or younger	132	3,658	(1.5%)	111	3,823	(1.6%)
18 to 19 years	330	14,564	(5.8%)	308	13,912	(5.7%)
20 to 24 years	1,658	68,695	(27.4%)	1,654	61,275	(25.1%)
25 to 29 years	1,981	82,611	(32.9%)	1,957	80,967	(33.1%)
30 to 34 years	1,329	53,578	(21.4%)	1,384	56,042	(22.9%)
35 to 39 years	582	23,080	(9.2%)	595	23,677	(9.7%)
40 years of age or older	108	4,639	(1.8%)	110	4,734	(1.9%)
RACE/ETHNICITY						
HISPANIC						
Yes	310	10,503	(4.2%)	330	10,328	(4.2%)
No	5,810	240,321	(95.8%)	5,789	234,103	(95.8%)
RACE/ETHNICITY						
Other Asian	68	2,925	(1.2%)	74	2,969	(1.2%)
White	5,563	222,328	(88.6%)	5,540	216,857	(88.7%)
Black	383	17,757	(7.1%)	396	18,174	(7.4%)
American Indian	39	1,400	(0.6%)	39	889	(0.4%)
Chinese	6	501	(0.2%)	11	1,080	(0.4%)
Japanese	3	114	(0.0%)	11	486	(0.2%)
Filipino	3	32	(0.0%)	4	116	(0.0%)
Hawaiian	2	95	(0.0%)	8	280	(0.1%)
Other Nonwhite	37	4,019	(1.6%)	21	2,221	(0.9%)
Alaskan Native	0	0	(0.0%)	0	0	(0.0%)
Mixed Race	16	1,653	(0.7%)	15	1,358	(0.6%)

INSURANCE STATUS (excludes Medicaid)						
Insured	4,229	178,561	(71.2%)	4,216	168,099	(68.8%)
Not insured	1,891	72,263	(28.8%)	1,903	76,331	(31.2%)
MEDICAID STATUS						
Enrolled in Medicaid	863	31,347	(12.5%)	849	30,029	(12.3%)
Not enrolled in Medicaid	5,257	219,478	(87.5%)	5,270	214,402	(87.7%)
INCOME LEVEL						
Less than $10,000	881	36,268	(14.5%)	876	33,946	(13.9%)
$10,000 to $14,999	529	22,018	(8.8%)	499	19,374	(7.9%)
$15,000 to $19,999	386	13,679	(5.5%)	364	14,269	(5.8%)
$20,000 to $24,999	467	18,735	(7.5%)	456	18,117	(7.4%)
$25,000 to $34,999	784	31,734	(12.7%)	783	31,453	(12.9%)
$35,000 to $49,999	898	34,711	(13.8%)	927	35,668	(14.6%)
$50,000 or more	2,175	93,679	(37.3%)	2,214	91,602	(37.5%)
EDUCATION LEVEL						
0-8 years	71	2,803	(1.1%)	63	3,150	(1.3%)
9-11 years	616	22,129	(8.8%)	587	18,344	(7.5%)
12 years	1,919	73,198	(29.2%)	1,905	74,408	(30.4%)
13-15 years	1,617	70,847	(28.2%)	1,620	71,840	(29.4%)
16 years or more	1,897	81,847	(32.6%)	1,944	76,688	(31.4%)

[a] Missing data not shown; percentages may not equal 100% due to rounding.

To determine differences between the two groups, the Rao-Scott modified chi square test was conducted regarding categorical variables, and unweighted two sample t-tests (Satterthwaite method reported) were conducted regarding continuous variables. Subsamples A and B did not differ with respect to the following demographic characteristics: maternal age [t (12,235) = -1.01, p = 0.16], maternal education [X^2 =

3.42, df = 4, p = 0.49], being insured [X^2 = 2.73, df = 1, p = 0.10], receiving Medicaid benefits [X^2 = 0.04, df = 1, p = 0.85], and Hispanic ethnicity [X^2 = 0.01, df = 1, p = 0.94]. The two groups did not differ on most maternal race categories: other Asian [X^2 = 0.02, df = 1, p = 0.88], black [X^2 = 0.21, df = 1, p = 0.64], American Indian [X^2 = 1.46, df = 1, p = 0.23], Chinese [X^2 = 1.68, df = 1, p = 0.20], Filipino [X^2 = 2.40, df = 1, p = 0.12], Hawaiian [X^2 = 2.09, df = 1, p = 0.15], other nonwhite [X^2 = 2.38, df = 1, p = 0.12], and mixed race [X^2 = 0.12, df = 1, p = 0.73]. The random groups differed regarding the Japanese maternal race category [X^2 = 4.84, df = 1, p = 0.03], but the sample size was extremely small with three and eleven participants in Subsamples A and B, respectively. The correlation matrix for all variables included in the confirmatory factor analysis (Subsample A) is provided in Table 10.

Table 10. Correlation matrix for the first random sample in Project 1.

PROJECT 1 Sample A N = 6,120	**CFA Correlation Matrix (w/ Variances on the Diagonal)**						
	Pregnancy Intention - Timing	Pregnancy Intention - Feeling	Maternal Race	Hispanic Ethnicity	Alcohol frequency before pregnancy	Binge drinking before pregnancy	Alcohol frequency after pregnancy
Pregnancy Intention – Trying							
Pregnancy Intention – Timing	-0.122						
Maternal Race	-0.265	0.052					
Hispanic Ethnicity	0.092	0.044	-0.480				
Alcohol frequency before pregnancy	0.163	-0.020	-0.012	-0.120			
Binge drinking before pregnancy	0.200	-0.007	-0.008	-0.047	0.880		
Alcohol frequency after pregnancy	0.085	0.085	-0.120	0.004	0.547	0.408	
Binge drinking after pregnancy	0.035	0.025	-0.083	-0.003	0.508	0.459	0.930

Testing the measurement model. Confirmatory factor analysis was conducted with Mplus using the mean and variance-adjusted weighted least squares estimator. This estimator calculates probit regressions for categorical factor indicators and linear regressions for continuous factor indicators (Muthen & Muthen, 2009). Therefore, this estimator accounts for the non-normality associated with categorical data and the lack of optimization. The CDC-provided complex analysis weights also were applied in Mplus using the finite population correction factor (a sampling fraction was calculated in SAS as SAMCNT/TOTCNT), the stratification variable (SUD_NEST), and the weight variable (WTANAL). According to the confirmatory factor analysis (CFA), the latent variance covariance matrix posed a problem with the pregnancy intention variable associated with trying to become pregnant, so it was removed from the CFA. Subsequently, there was a problem with the maternal race and Hispanic ethnicity variables, so they were removed from the CFA. Then, there was a problem with the preconception alcohol variable, so it was removed from the CFA. At this point, the framework was reevaluated, and the latent variables were removed to be replaced by their measured components. With no latent variables in the model, confirmatory factor analysis was deemed unnecessary and subsamples A and B were recombined into one dataset.

In addition to the elimination of latent variables, several other variables were altered as well. The components of prenatal education were assigned a “1” for a “yes” response (affirmative to talking to a health care provider about the issue) and a “0” for a “no” response, and the affirmative responses were summed. Thus, prenatal education became a continuous measured variable ranging from 0 (didn’t talk to a medical provider) to 10 (talked with a provider about many issues related to pregnancy). In a similar way, maternal complications were re-coded, summed, and compiled into one measured variable ranging from 0 (experienced no complications) to 10 (experienced all complications listed). Therefore, the revised just-identified framework included 32

measured independent variables and one measured dependent variable in Project 1, as shown in Figure 7. Project 2 comprised the same framework with the exclusion of the preconception oral care and preconception medical care variables associated only with Project 1.

Assumptions and Issues of Concern

Taking into account the non-normal and non-linear categorical nature of many of the variables, as well as the complex analysis weights inherent in the PRAMS datasets, the maximum likelihood estimator with robust standard errors (MLR) was used in the revised analysis. This estimator, computed using a sandwich estimator, is robust to non-normality and non-independence of observations when dealing with complex analysis weights (Muthen, 2009). In addition, the MLR estimator protects against heteroscedasticity (White, 1980). Another issue of possible concern was multicollinearity. Multicollinearity is difficult to assess in Mplus and SAS when working with complex analysis weights. However, the correlations derived from all variations of the framework, as well as the large sample size, indicated that multicollinearity was not a pertinent factor in this analysis. To triangulate this finding, a test of multicollinearity was performed on the unweighted sample of Project 1. As a rule of thumb when testing for multicollinearity, a variance inflation factor (VIF) greater than 10 indicates the need for further investigation (Marquardt, 1970; Mason, et al., 1970; Menard, 1995). The VIFs for all variables in the model in Project 1 were well below 10, with the highest value associated with the postnatal maternal smoking variable at 4.68. Therefore, multicollinearity was not deemed a pertinent factor in this analysis.

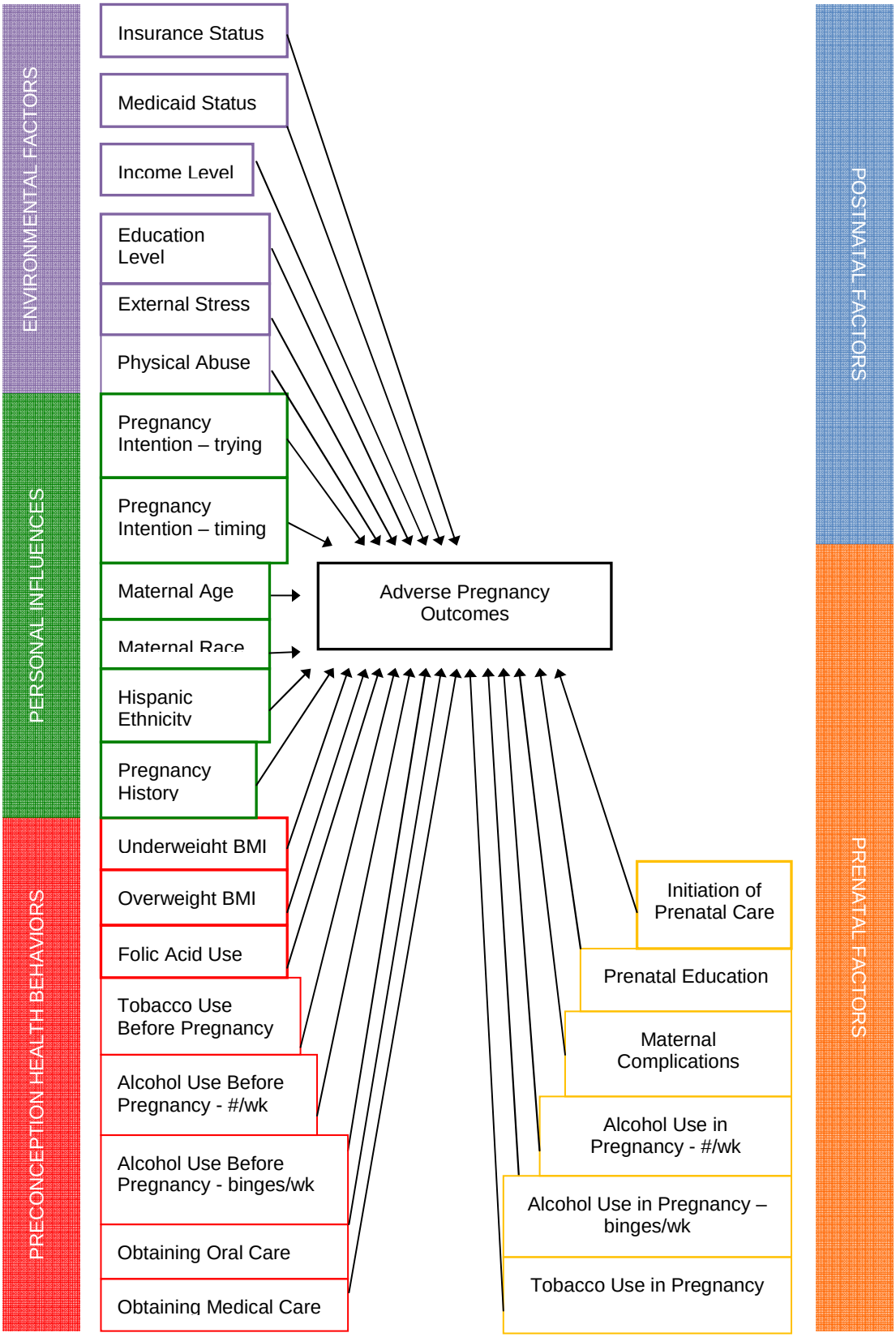


Figure 7. Revised preconception framework.

Descriptive Statistics

Due to list-wise deletion, the sample in Project 1 contained 12,239 participants as compared to the original 27,933 participants. The sample in Project 2 contained 128,551 participants as compared to the original 200,008 participants. The demographic characteristics of each sample are listed in Table 11. Frequency distributions for all variables for each sample are included in Appendix A. In comparison, the demographic characteristics of participants deleted by list-wise deletion are displayed in Table 12.

Table 11. Demographic characteristics of Projects 1 and 2.

	Project 1 (N=12,239)			**Project 2 (N=128,551)**		
Variables	**Freq.**	**Weighted Frequency**	**Percent**	**Freq.**	**Weighted Frequency**	**Percent**
AGE						
17 years of age or younger	243	7,480	(1.5%)	3,153	114,074	(2.0%)
18 to 19 years	638	28,476	(5.7%)	8,392	330,978	(5.7%)
20 to 24 years	3,012	129,969	(26.2%)	31,759	1,358,219	(23.6%)
25 to 29 years	3,938	163,577	(33.0%)	36,380	1,701,642	(29.5%)
30 to 34 years	2,713	109,619	(22.1%)	29,058	1,414,774	(24.5%)
35 to 39 years	1,177	46,757	(9.4%)	16,240	696,919	(12.1%)
40 years of age or older	218	9,375	(1.9%)	3,569	148,390	(2.6%)
RACE/ETHNICITY						
HISPANIC						
Yes	640	20,831	(4.2%)	13,909	657,016	(11.4%)
No	11,599	474,424	(95.8%)	114,642	5,107,979	(88.6%)
RACE/ETHNICITY						
Other Asian	142	5,895	(1.2%)	5,038	149,348	(2.6%)
White	11,103	439,185	(88.7%)	86,917	4,380,459	(76.0%)
Black	779	35,931	(7.3%)	21,615	884,073	(15.3%)

American Indian	78	2,288	(0.5%)	3,611	55,038	(1.0%)
Chinese	17	1,581	(0.3%)	1,682	41,826	(0.7%)
Japanese	14	601	(0.1%)	988	14,176	(0.2%)
Filipino	7	148	(0.0%)	1,960	38,683	(0.7%)
Hawaiian	10	376	(0.1%)	1,296	17,703	(0.3%)
Other Nonwhite	58	6,240	(1.3%)	2,612	129,341	(2.2%)
Alaskan Native	0	0	(0.0%)	1,400	7,218	(0.1%)
Mixed Race	31	3,011	(0.6%)	1,432	47,130	(0.8%)
INSURANCE STATUS (excludes Medicaid)						
Insured	8,445	346,660	(70.0%)	80,727	3,777,541	(65.5%)
Not insured	3,794	148,595	(30.0%)	47,824	1,987,455	(34.5%)
MEDICAID STATUS						
Enrolled in Medicaid	1,712	61,375	(12.4%)	18,629	754,826	(13.1%)
Not enrolled in Medicaid	10,527	433,880	(87.6%)	109,922	5,010,170	(86.9%)
INCOME LEVEL						
Less than $10,000	1,757	70,215	(14.2%)	25,437	988,505	(17.1%)
$10,000 to $14,999	1,028	41,392	(8.4%)	11,944	491,887	(8.5%)
$15,000 to $19,999	750	27,948	(5.6%)	8,439	364,991	(6.3%)
$20,000 to $24,999	923	36,853	(7.4%)	9,533	415,866	(7.2%)
$25,000 to $34,999	1,567	63,187	(12.8%)	13,455	595,318	(10.3%)
$35,000 to $49,999	1,825	70,379	(14.2%)	14,417	634,854	(11.0%)
$50,000 or more	4,389	185,282	(37.4%)	45,326	2,273,575	(39.4%)
EDUCATION LEVEL						
0-8 years	134	5,953	(1.2%)	2,749	135,998	(2.4%)
9-11 years	1,203	40,474	(8.2%)	14,661	604,889	(10.5%)
12 years	3,824	147,605	(29.8%)	38,412	1,625,109	(28.2%)
13-15 years	3,237	142,688	(28.8%)	32,727	1,460,212	(25.3%)
16 years or more	3,841	158,535	(32.0%)	40,002	1,938,786	(33.6%)

[a] Missing data not shown; percentages may not equal 100% due to rounding.

Table 12. Demographic characteristics of participants deleted in a list-wise manner from Projects 1 and 2 due to missing data.

Infant Mortality Sample[a]	**Project 1 (N=15,694)**			**Project 2 (N=71,457)**		
	Freq.	**Weighted Frequency**	**Percent**	**Freq.**	**Weighted Frequency**	**Percent**
AGE						
17 years of age or younger	543	22,240	(3.2%)	4,134	163,619	(5.4%)
18 to 19 years of age	943	37,093	(5.3%)	6,475	250,538	(8.3%)
20 to 24 years of age	3,627	144,586	(20.8%)	17,623	740,295	(24.6%)
25 to 29 years of age	4,268	185,650	(26.8%)	17,703	788,374	(26.2%)
30 to 34 years of age	3,792	181,390	(26.2%)	14,462	633,194	(21.1%)
35 to 39 years of age	2,034	99,565	(14.4%)	8,693	345,751	(11.5%)
40 years of age or older	487	22,868	(3.3%)	2,355	84,115	(2.8%)
RACE/ETHNICITY						
HISPANIC						
Yes	3,553	145,406	(21.2%)	16,503	788,092	(26.8%)
No	12,006	541,770	(78.8%)	52,588	2,149,789	(73.2%)
RACE/ETHNICITY						
Other Asian	1,072	31,709	(4.6%)	3,333	107,233	(3.6%)
White	10,978	506,070	(73.6%)	42,242	2,018,631	(68.0%)
Black	2,522	106,603	(15.5%)	14,019	561,296	(18.9%)
American Indian	106	2,925	(0.4%)	2,128	27,020	(0.9%)
Chinese	252	7,641	(1.1%)	807	20,581	(0.7%)
Japanese	38	1,462	(0.2%)	475	7,758	(0.3%)
Filipino	223	6,107	(0.9%)	1,257	29,200	(1.0%)
Hawaiian	12	247	(0.0%)	771	10,880	(0.4%)
Other Nonwhite	322	21,956	(3.2%)	3,060	155,168	(5.2%)
Alaskan Native	0	0	(0.0%)	1,206	5,934	(0.2%)
Mixed Race	19	2,686	(0.4%)	660	23,701	(0.8%)
INSURANCE STATUS						

(excludes Medicaid)						
Insured	9,057	437,952	(63.4%)	35,007	1,456,996	(48.9%)
Not insured	6,556	252,311	(36.6%)	35,798	1,523,850	(51.1%)
MEDICAID STATUS						
Enrolled in Medicaid	2,615	96,665	(14.0%)	14,030	541,198	(18.2%)
Not enrolled in Medicaid	12,989	593,206	(86.0%)	56,625	2,434,556	(81.8%)
INCOME LEVEL						
Less than $10,000	3.014	114,767	(18.9%)	16,141	630,288	(28.2%)
$10,000 to $14,999	1,336	51,688	(8.5%)	6,138	253,766	(11.3%)
$15,000 to $19,999	917	37,238	(6.1%)	4,010	157,100	(7.0%)
$20,000 to $24,999	973	38,682	(6.4%)	4,142	162,024	(7.2%)
$25,000 to $34,999	1,355	56,718	(9.3%)	5,307	206,471	(9.2%)
$35,000 to $49,999	1,337	56,964	(9.4%)	5,149	202,645	(9.0%)
$50,000 or more	4,710	250,610	(41.3%)	14,207	624,616	(27.9%)
EDUCATION LEVEL						
0-8 years	997	42,075	(6.2%)	5,725	284,774	(9.9%)
9-11 years	2,605	88,351	(13.0%)	13,704	569,697	(19.8%)
12 years	4,489	192,600	(28.4%)	21,848	878,657	(30.5%)
13-15 years	2,946	136,524	(20.1%)	13,468	541,644	(18.8%)
16 years or more	4,177	218,150	(32.2%)	13,852	605,350	(21.0%)
[a] Percentages may not equal 100% due to rounding.						

To determine differences between the two groups, the Rao-Scott modified chi square test was conducted regarding categorical variables, and unweighted two sample t-tests (Satterthwaite method reported) were conducted regarding continuous variables. In Project 1, participants included in the study differed from participants excluded from the study with respect to the following demographic characteristics: maternal age [t (27,417) = 8.43, p<.0001], maternal education [X^2 = 250.45, df = 4, p<.0001], being insured [X^2 = 41.60, df = 1, p<.0001], and Hispanic ethnicity [X^2 = 985.50, df = 1, p<.0001]. The two

groups differed according to the following maternal race categories: other Asian [X^2 = 131.64, df = 1, p<.0001], black [X^2 = 267.20, df = 1, p<.0001], Chinese [X^2 = 25.36, df = 1, p<.0001], Filipino [X^2 = 137.63, df = 1, p<.0001], and other nonwhite [X^2 = 30.09, df = 1, p<.0001]. The groups did not differ with respect to American Indian maternal race [X^2 = 1.52, df = 1, p = 0.22], Japanese maternal race [X^2 = 0.50, df = 1, p = 0.48], Hawaiian maternal race [X^2 = 1.82, df = 1, p = 0.18], mixed maternal race [X^2 = 3.08, df = 1, p = 0.08], and receiving Medicaid benefits [X^2 = 1.53, df = 1, p = 0.22]. Also in Project 1, participants included in the study differed from participants excluded from the study with respect to the following selected variables: adverse pregnancy outcomes [t (24,005) = -12.55, p <0.0001], dental visit before pregnancy [X^2 = 6.47, df = 1, p = 0.01], talking with a health care provider before pregnancy [X^2 = 39.49, df = 1, p<.0001], folic acid use [X^2 = 61.80, df = 3, p<.0001], tobacco use before pregnancy [X^2 = 64.28, df = 6, p<.0001], alcohol frequency before pregnancy [X^2 = 13.47, df = 5, p = 0.02], and binge drinking before pregnancy [X^2 = 33.60, df = 5, p<.0001].

In Project 2, participants included in the study differed from participants excluded from the study with respect to the following demographic characteristics: maternal age [t (134,600) = -25.63, p <0.0001], maternal education [X^2 = 4,023.00, df = 4, p<.0001], being insured [X^2 = 1,882.00, df = 1, p<.0001], receiving Medicaid benefits [X^2 = 333.86, df = 1, p<.0001], and Hispanic ethnicity [X^2 = 2,751.01, df = 1, p<.0001]. The two groups differed according to the following maternal race categories: other Asian [X^2 = 65.28, df = 1, p<.0001], black [X^2 = 132.85, df = 1, p<.0001], Filipino [X^2 = 33.44, df = 1, p<.0001], Hawaiian maternal race [X^2 = 9.04, df = 1, p = 0.003], other nonwhite [X^2 = 443.59, df = 1, p<.0001], and Alaskan native [X^2 = 139.84, df = 1, p<.0001]. The groups did not differ with respect to American Indian maternal race [X^2 = 1.12, df = 1, p = 0.29], Chinese maternal race [X^2 = 0.50, df = 1, p = 0.48], Japanese maternal race [X^2 = 0.29, df = 1, p = 0.59, and mixed maternal race [X^2 = 0.12, df = 1, p = 0.73]. Also in Project 2,

participants included in the study differed from participants excluded from the study with respect to the following selected variables: adverse pregnancy outcomes [t (79,172) = 5.26, p <0.0001], folic acid use [X^2 = 277.20, df = 3, p<.0001], tobacco use before pregnancy [X^2 = 188.49, df = 6, p<.0001], alcohol frequency before pregnancy [X^2 = 2,033.02, df = 5, p<.0001], and binge drinking before pregnancy [X^2 = 2,188.39, df = 5, p<.0001].

In both projects, those participants excluded from the study were more extreme in maternal age (younger and older), more racially diverse (more identified as black and other racial categories; more identified as Hispanic ethnicity), uninsured, receiving Medicaid, with less income, and with less education. These differences will be discussed at greater length in the next chapter. The correlation matrices associated with the variables in Projects 1 and 2 are represented in Tables 13 and 14, respectively.

Table 13. Correlation matrix - Project 1.

PROJECT 1	**Correlation Matrix**													
	ADVERSE PREGNANCY OUTCOMES	INSURED	MEDICAID	INCOME	EDUCATION	STRESS	ABUSE BEFORE PREGNANCY	PREGNANCY TRYING	INTENTION SOONER	INTENTION LATER	INTENTION NEVER	MATERNAL AGE	HISPANIC	OTHER ASIAN
ADVERSE PREGNANCY OUTCOMES	1.000													
INSURED	-0.039	1.000												
MEDICAID	0.046	-0.404	1.000											
INCOME	-0.072	0.590	-0.413	1.000										
EDUCATION	-0.047	0.428	-0.268	0.531	1.000									
STRESS	0.090	-0.354	0.231	-0.466	-0.317	1.000								
ABUSE BEFORE PREGNANCY	0.051	-0.150	0.106	-0.196	-0.166	0.348	1.000							
PREGNANCY – TRYING	-0.030	0.310	-0.182	0.370	0.296	-0.331	-0.118	1.000						
INTENTION – SOONER	0.008	0.146	-0.092	0.180	0.136	-0.126	-0.030	0.316	1.000					
INTENTION – LATER	0.009	-0.218	0.111	-0.274	-0.215	0.239	0.065	-0.603	-0.309	1.000				
INTENTION – NEVER	0.022	-0.126	0.096	-0.148	-0.110	0.165	0.095	-0.334	-0.157	-0.209	1.000			
MATERNAL AGE	-0.005	0.336	-0.187	0.513	0.455	-0.297	-0.133	0.225	0.198	-0.297	0.016	1.000		
HISPANIC	0.009	-0.071	-0.019	-0.102	-0.106	0.036	0.033	-0.024	-0.006	0.038	-0.014	-0.028	1.000	
RACE – OTHER ASIAN	-0.002	0.015	0.009	-0.002	0.048	-0.024	-0.010	-0.003	-0.003	0.009	-0.013	0.020	-0.017	1.000
RACE – BLACK	0.103	-0.100	0.159	-0.245	-0.112	0.150	0.075	-0.177	-0.077	0.098	0.165	-0.079	-0.039	-0.031
RACE – AMERICAN INDIAN	0.021	-0.029	0.021	-0.038	-0.053	0.029	-0.002	-0.015	-0.021	-0.002	0.016	-0.002	-0.008	-0.007
RACE – CHINESE	-0.008	0.034	-0.020	0.009	0.062	-0.035	-0.012	0.030	0.013	-0.035	-0.011	0.050	-0.012	-0.006
RACE – JAPANESE	-0.005	0.020	-0.013	0.022	0.022	-0.015	-0.008	0.021	0.042	-0.016	-0.011	0.042	-0.007	-0.004
RACE – FILIPINO	-0.001	0.004	-0.001	-0.009	0.006	-0.005	-0.004	0.001	0.011	0.006	-0.006	-0.004	-0.004	-0.002
RACE – HAWAIIAN	-0.015	-0.010	0.005	-0.003	0.005	0.009	0.009	0.000	-0.004	0.018	-0.009	-0.002	0.010	-0.003
RACE – OTHER NONWHITE	0.006	0.011	0.002	-0.029	-0.037	0.040	0.016	-0.025	0.029	0.008	0.030	-0.001	0.390	-0.012
RACE – MIXED RACE	0.025	-0.011	-0.013	-0.033	-0.003	0.046	0.012	-0.030	-0.018	0.025	0.011	-0.033	0.041	-0.009

PROJECT 1 (continued)	Correlation Matrix													
	ADVERSE PREGNANCY OUTCOMES	INSURED	MEDICAID	INCOME	EDUCATION	STRESS	ABUSE BEFORE PREGNANCY	PREGNANCY TRYING	INTENTION SOONER	INTENTION LATER	INTENTION NEVER	MATERNAL AGE	HISPANIC	OTHER ASIAN
PREGNANCY HISTORY – NO HISTORY	0.097	0.003	-0.136	-0.109	0.007	0.036	0.018	0.016	0.042	0.050	-0.105	-0.330	-0.028	0.005
PREGNANCY HISTORY – LOW BIRTH WEIGHT	0.022	-0.012	0.031	-0.039	-0.047	0.026	-0.002	-0.027	-0.010	0.026	-0.007	0.022	0.000	0.009
PREGNANCY HISTORY – PRETERM	0.046	-0.054	0.076	-0.026	-0.045	0.074	0.058	-0.014	0.006	-0.002	0.041	0.025	0.004	-0.009
PREGNANCY HISTORY – LOW BIRTH WEIGHT & PRETERM	0.121	-0.038	0.049	-0.054	-0.061	0.046	0.027	-0.025	0.012	-0.015	0.058	-0.006	0.006	0.021
BMI - UNDERWEIGHT	0.017	-0.077	0.039	-0.091	-0.054	0.050	0.008	-0.049	-0.018	0.004	0.024	-0.082	0.002	-0.002
BMI – OVERWEIGHT	0.046	-0.019	0.050	-0.046	-0.082	0.081	0.006	-0.062	0.046	0.022	0.064	0.070	0.008	-0.012
FOLIC ACID USE	0.000	0.249	-0.124	0.313	0.318	-0.252	-0.111	0.354	0.151	-0.217	-0.150	0.266	-0.029	-0.008
TOBACCO USE BEFORE PREGNANCY	0.050	-0.309	0.194	-0.321	-0.334	0.310	0.116	-0.241	-0.082	0.133	0.157	-0.217	-0.059	-0.030
ALCOHOL FREQUENCY BEFORE PREGNANCY	0.003	-0.071	0.024	-0.043	-0.014	0.185	0.086	-0.139	-0.066	0.102	0.060	0.002	-0.038	-0.029
BINGE DRINKING BEFORE PREGNANCY	0.009	-0.103	0.037	-0.082	-0.076	0.222	0.097	-0.162	-0.069	0.124	0.052	-0.061	-0.021	-0.033
DENTAL VISIT BEFORE PREGNANCY	-0.012	0.172	-0.067	0.202	0.188	-0.138	-0.103	0.112	0.041	-0.056	-0.061	0.126	-0.054	-0.003
TALK W/ HEALTH PROVIDER BEFORE PREGNANCY	0.064	0.229	-0.071	0.272	0.244	-0.201	-0.085	0.399	0.221	-0.240	-0.167	0.203	-0.024	0.013
TOBACCO USE DURING PREGNANCY	0.050	-0.259	0.187	-0.289	-0.294	0.266	0.128	-0.176	-0.060	0.083	0.150	-0.143	-0.047	-0.034
ALCOHOL FREQUENCY DURING PREGNANCY	-0.014	-0.007	0.046	-0.001	-0.007	0.059	0.050	-0.046	-0.005	0.023	0.009	0.078	0.000	0.020
BINGE DRINKING DURING PREGNANCY	-0.013	0.024	0.021	0.024	-0.001	0.038	0.047	-0.015	-0.014	0.010	0.000	0.094	-0.002	0.016
MATERNAL COMPLICATIONS	0.296	-0.102	0.113	-0.161	-0.156	0.267	0.116	-0.128	-0.002	0.082	0.075	-0.089	-0.008	-0.035
PRENATAL EDUCATION	0.049	-0.125	0.114	-0.182	-0.157	0.102	0.032	-0.117	-0.067	0.087	0.058	-0.153	0.011	-0.017
PRENATAL CARE INITIATION	0.000	-0.160	0.027	-0.134	-0.121	0.089	0.063	-0.135	-0.083	0.098	0.094	-0.085	0.017	-0.003

PROJECT 1 (continued)	Correlation Matrix													
	BLACK	AMERICAN INDIAN	CHINESE	JAPANESE	FILIPINO	HAWAIIAN	OTHER NONWHITE	MIXED RACE	PREGNANCY HISTORY NO HISTORY	PREGNANCY HISTORY -LOW BIRTH WEIGHT	PREGNANCY HISTORY PRETERM	PREGNANCY HISTORY -LOW BIRTH WEIGHT & PRETERM	BMI UNDERWEIGHT	BMI OVERWEIGHT
RACE – BLACK	1.000													
RACE – AMERICAN INDIAN	-0.019	1.000												
RACE - CHINESE	-0.016	-0.004	1.000											
RACE - JAPANESE	-0.010	-0.002	-0.002	1.000										
RACE – FILIPINO	-0.005	-0.001	-0.001	-0.001	1.000									
RACE – HAWAIIAN	-0.008	-0.002	-0.002	-0.001	0.000	1.000								
RACE – OTHER NONWHITE	-0.032	-0.008	-0.006	-0.004	-0.002	-0.003	1.000							
RACE – MIXED RACE	-0.022	-0.005	-0.004	-0.003	-0.001	-0.002	-0.009	1.000						
PREGNANCY HISTORY – NO HISTORY	-0.019	-0.022	-0.010	0.013	0.018	-0.007	-0.025	0.044	1.000					
PREGNANCY HISTORY – LOW BIRTH WEIGHT	0.061	0.007	0.051	-0.005	-0.002	-0.004	0.014	-0.011	-0.112	1.000				
PREGNANCY HISTORY – PRETERM	0.015	0.004	-0.003	-0.007	-0.003	-0.006	0.003	-0.013	-0.161	-0.028	1.000			
PREGNANCY HISTORY – LOW BIRTH WEIGHT & PRETERM	0.075	0.043	-0.010	0.000	-0.003	-0.005	0.018	-0.008	-0.138	-0.024	-0.035	1.000		
BMI – UNDERWEIGHT	-0.001	-0.007	-0.005	0.017	0.024	-0.006	-0.004	-0.012	0.063	-0.004	0.021	-0.018	1.000	
BMI – OVERWEIGHT	0.083	-0.012	-0.033	-0.022	-0.011	-0.005	0.003	0.016	-0.063	0.001	0.041	0.016	-0.185	1.000
FOLIC ACID USE	-0.093	-0.009	0.044	0.023	-0.002	-0.016	0.004	-0.029	0.013	-0.014	-0.002	-0.045	-0.014	-0.073
TOBACCO BEFORE PREGNANCY	-0.014	0.005	-0.029	-0.016	-0.009	-0.009	-0.029	-0.008	0.050	0.004	0.004	0.036	0.056	0.037
ALCOHOL FREQUENCY BEFORE PREGNANCY	-0.002	-0.003	-0.019	-0.008	-0.011	-0.012	-0.009	0.000	0.141	-0.010	-0.017	-0.010	-0.002	0.003
BINGE DRINKING BEFORE PREGNANCY	-0.013	-0.001	-0.029	-0.009	-0.011	-0.009	-0.007	0.013	0.127	-0.013	-0.023	-0.013	0.001	0.022
DENTAL VISIT BEFORE PREGNANCY	-0.053	-0.020	0.022	0.009	-0.010	-0.020	-0.054	0.006	0.011	-0.016	-0.035	-0.033	-0.017	-0.032
TALK W/ HEALTH PROVIDER BEFORE PREGNANCY	-0.053	-0.005	0.037	0.008	-0.006	-0.010	0.002	0.016	0.077	-0.002	0.027	0.011	-0.010	-0.028

PROJECT 1 (continued)	Correlation Matrix													
	BLACK	AMERICAN INDIAN	CHINESE	JAPANESE	FILIPINO	HAWAIIAN	OTHER NONWHITE	MIXED RACE	PREGNANCY HISTORY NO HISTORY	PREGNANCY HISTORY -LOW BIRTH WEIGHT	PREGNANCY HISTORY PRETERM	PREGNANCY HISTORY -LOW BIRTH WEIGHT & PRETERM	BMI UNDERWEIGHT	BMI OVERWEIGHT
TOBACCO DURING PREGNANCY	-0.009	0.014	-0.021	-0.011	-0.006	-0.005	-0.022	-0.007	-0.027	0.014	0.026	0.039	0.044	0.042
ALCOHOL FREQUENCY DURING PREGNANCY	0.020	-0.004	-0.012	-0.007	-0.004	0.011	0.014	0.016	-0.027	0.013	0.049	-0.013	-0.023	-0.041
BINGE DRINKING BEFORE PREGNANCY	0.034	-0.004	-0.012	-0.007	-0.004	0.013	0.006	-0.002	-0.036	0.006	0.016	-0.014	-0.023	-0.028
MATERNAL COMPLICATIONS	0.075	0.024	-0.025	-0.010	-0.001	0.002	0.010	0.006	-0.025	0.013	0.140	0.095	0.005	0.146
PRENATAL EDUCATION	0.147	-0.004	-0.010	-0.011	0.000	-0.007	0.008	-0.006	0.133	0.030	0.015	0.019	0.011	0.028
PRENATAL CARE INITIATION	0.056	0.003	-0.013	0.002	-0.004	0.005	-0.006	0.011	-0.045	-0.007	0.013	-0.017	0.026	-0.014

PROJECT 1 (continued)	Correlation Matrix											
	FOLIC ACID	TOBACCO BEFORE PREGNANCY	ALCOHOL FREQUENCY BEFORE PREGNANCY	BINGE DRINKING BEFORE PREGNANCY	DENTAL VISIT BEFORE PREGNANCY	TALK W/HEALTH PROVIDER BEFORE PREGNANCY	TOBACCO DURING PREGNANCY	ALCOHOL FREQUENCY DURING PREGNANCY	BINGE DRINKING DURING PREGNANCY	MATERNAL COMPLICATIONS	PRENATAL EDUCATION	PRENATAL CARE INITIATION
FOLIC ACID USE	1.000											
TOBACCO BEFORE PREGNANCY	-0.236	1.000										
ALCOHOL FREQUENCY BEFORE PREGNANCY	-0.072	0.271	1.000									
BINGE DRINKING BEFORE PREGNANCY	-0.116	0.302	0.802	1.000								
DENTAL VISIT BEFORE PREGNANCY	0.124	-0.093	-0.020	-0.023	1.000							
TALK W/ HEALTH PROVIDER BEFORE PREGNANCY	0.426	-0.165	-0.027	-0.075	0.078	1.000						
TOBACCO DURING PREGNANCY	-0.171	0.735	0.157	0.193	-0.074	-0.115	1.000					
ALCOHOL FREQUENCY DURING PREGNANCY	0.017	0.021	0.283	0.186	-0.048	0.012	0.030	1.000				
BINGE DRINKING DURING PREGNANCY	0.005	0.031	0.229	0.191	-0.016	0.001	0.032	0.776	1.000			
MATERNAL COMPLICATIONS	-0.090	0.124	0.018	0.029	-0.069	-0.013	0.132	-0.009	-0.006	1.000		
PRENATAL EDUCATION	-0.013	0.133	0.096	0.095	-0.032	0.050	0.087	0.031	0.018	0.048	1.000	
PRENATAL CARE INITIATION	-0.079	0.036	-0.044	-0.029	-0.031	-0.123	0.057	0.018	0.001	-0.061	-0.038	1.000

Table 14. Correlation matrix – Project 2.

PROJECT 2	Correlation Matrix													
	ADVERSE PREGNANCY OUTCOMES	INSURED	MEDICAID	INCOME	EDUCATION	STRESS	ABUSE BEFORE PREGNANCY	PREGNANCY TRYING	INTENTION SOONER	INTENTION LATER	INTENTION NEVER	MATERNAL AGE	HISPANIC	OTHER ASIAN
ADVERSE PREGNANCY OUTCOMES	1.000													
INSURED	-0.018	1.000												
MEDICAID	0.035	-0.338	1.000											
INCOME	-0.047	0.627	-0.399	1.000										
EDUCATION	-0.027	0.458	-0.283	0.575	1.000									
STRESS	0.049	-0.305	0.185	-0.399	-0.261	1.000								
ABUSE BEFORE PREGNANCY	0.027	-0.152	0.101	-0.196	-0.140	0.344	1.000							
PREGNANCY – TRYING	-0.015	0.291	-0.165	0.371	0.274	-0.284	-0.109	1.000						
INTENTION – SOONER	0.034	0.133	-0.085	0.162	0.116	-0.105	-0.037	0.318	1.000					
INTENTION – LATER	-0.001	-0.207	0.099	-0.280	-0.192	0.204	0.076	-0.579	-0.307	1.000				
INTENTION – NEVER	0.025	-0.120	0.100	-0.143	-0.117	0.156	0.074	-0.310	-0.151	-0.215	1.000			
MATERNAL AGE	0.018	0.331	-0.217	0.487	0.448	-0.263	-0.124	0.258	0.193	-0.325	0.022	1.000		
HISPANIC	0.005	-0.168	0.029	-0.197	-0.233	0.018	0.028	-0.039	-0.028	0.053	-0.019	-0.063	1.000	
RACE – OTHER ASIAN	0.005	0.030	-0.023	0.036	0.070	-0.064	-0.020	0.037	0.035	-0.020	-0.017	0.046	-0.040	1.000
RACE – BLACK	0.105	-0.159	0.209	-0.266	-0.127	0.138	0.062	-0.206	-0.076	0.118	0.153	-0.127	-0.105	-0.069
RACE – AMERICAN INDIAN	0.000	-0.054	0.025	-0.052	-0.049	0.047	0.022	-0.025	-0.011	0.013	0.014	-0.037	-0.017	-0.016
RACE – CHINESE	-0.001	0.029	-0.017	0.030	0.053	-0.046	-0.014	0.031	0.026	-0.021	-0.010	0.060	-0.029	-0.014
RACE – JAPANESE	-0.002	0.022	-0.010	0.024	0.027	-0.022	-0.006	0.016	0.020	-0.011	-0.006	0.034	-0.010	-0.008
RACE – FILIPINO	0.007	0.021	-0.014	0.016	0.024	-0.022	-0.005	-0.002	0.006	0.001	-0.002	0.026	0.002	-0.013
RACE – HAWAIIAN	-0.005	0.006	0.028	-0.019	-0.017	0.010	0.007	-0.017	-0.007	0.010	0.008	-0.018	0.016	-0.009
RACE – OTHER NONWHITE	-0.005	-0.073	0.015	-0.085	-0.105	0.007	0.009	-0.016	-0.006	0.021	-0.013	-0.024	0.331	-0.025
RACE – MIXED RACE	-0.001	-0.025	0.009	-0.017	-0.023	0.008	0.009	-0.006	-0.004	0.003	0.005	-0.013	-0.008	-0.006

PROJECT 2 (continued)	Correlation Matrix													
	ADVERSE PREGNANCY OUTCOMES	INSURED	MEDICAID	INCOME	EDUCATION	STRESS	ABUSE BEFORE PREGNANCY	PREGNANCY TRYING	INTENTION SOONER	INTENTION LATER	INTENTION NEVER	MATERNAL AGE	HISPANIC	OTHER ASIAN
PREGNANCY HISTORY – NO HISTORY	0.090	0.038	-0.118	-0.030	0.055	0.003	0.000	0.032	0.064	0.073	-0.142	-0.280	-0.024	0.021
PREGNANCY HISTORY – LOW BIRTH WEIGHT	0.015	-0.056	0.050	-0.065	-0.070	0.024	0.016	-0.037	-0.014	0.007	0.042	0.027	0.055	0.011
PREGNANCY HISTORY – PRETERM	0.042	-0.017	0.040	-0.015	-0.035	0.035	0.025	-0.010	-0.009	-0.006	0.031	0.032	0.014	-0.001
PREGNANCY HISTORY – LOW BIRTH WEIGHT & PRETERM	0.102	-0.035	0.064	-0.044	-0.046	0.027	0.015	-0.020	0.000	-0.001	0.028	0.020	0.009	0.000
BMI - UNDERWEIGHT	-0.001	-0.063	0.026	-0.074	-0.051	0.036	0.026	-0.045	-0.026	0.042	0.002	-0.085	-0.013	0.034
BMI – OVERWEIGHT	0.063	-0.044	0.062	-0.069	-0.092	0.079	0.004	-0.053	0.031	0.002	0.059	0.044	0.010	-0.061
FOLIC ACID USE	0.017	0.278	-0.112	0.328	0.298	-0.231	-0.104	0.349	0.170	-0.241	-0.133	0.272	-0.088	0.017
TOBACCO BEFORE PREGNANCY	0.014	-0.219	0.119	-0.238	-0.260	0.285	0.141	-0.178	-0.062	0.113	0.095	-0.179	-0.097	-0.058
ALCOHOL FREQUENCY BEFORE PREGNANCY	-0.028	0.069	-0.079	0.121	0.133	0.097	0.062	-0.029	-0.026	0.032	0.020	0.061	-0.113	-0.076
BINGE DRINKING BEFORE PREGNANCY	-0.026	0.033	-0.058	0.070	0.070	0.135	0.079	-0.060	-0.040	0.063	0.020	-0.012	-0.096	-0.074
TOBACCO USE DURING PREGNANCY	0.007	-0.206	0.139	-0.226	-0.241	0.249	0.133	-0.139	-0.049	0.069	0.108	-0.114	-0.083	-0.044
ALCOHOL FREQUENCY DURING PREGNANCY	-0.018	0.038	-0.019	0.062	0.066	0.007	0.014	0.019	-0.001	-0.013	0.006	0.092	-0.009	-0.017
BINGE DRINKING DURING PREGNANCY	-0.013	0.033	-0.018	0.057	0.057	0.003	0.007	0.020	-0.001	-0.014	0.005	0.079	-0.006	-0.017
MATERNAL COMPLICATIONS	0.276	-0.100	0.085	-0.141	-0.137	0.237	0.097	-0.083	0.015	0.045	0.067	-0.091	0.000	-0.036
PRENATAL EDUCATION	0.026	-0.120	0.103	-0.176	-0.174	0.034	0.008	-0.079	-0.039	0.064	0.017	-0.154	0.042	-0.017
PRENATAL CARE INITIATION	-0.009	-0.226	0.073	-0.236	-0.202	0.131	0.074	-0.203	-0.107	0.132	0.132	-0.172	0.061	-0.010

PROJECT 2 (continued)	Correlation Matrix													
	BLACK	AMERICAN INDIAN	CHINESE	JAPANESE	FILIPINO	HAWAIIAN	OTHER NONWHITE	MIXED RACE	PREGNANCY HISTORY NO HISTORY	PREGNANCY HISTORY -LOW BIRTH WEIGHT	PREGNANCY HISTORY PRETERM	PREGNANCY HISTORY -LOW BIRTH WEIGHT & PRETERM	BMI UNDERWEIGHT	BMI OVERWEIGHT
RACE – BLACK	1.000													
RACE – AMERICAN INDIAN	-0.042	1.000												
RACE - CHINESE	-0.036	-0.008	1.000											
RACE - JAPANESE	-0.021	-0.005	-0.004	1.000										
RACE – FILIPINO	-0.035	-0.008	-0.007	-0.004	1.000									
RACE – HAWAIIAN	-0.024	-0.005	-0.005	-0.003	-0.005	1.000								
RACE – OTHER NONWHITE	-0.064	-0.015	-0.013	-0.008	-0.012	-0.008	1.000							
RACE – MIXED RACE	-0.015	-0.003	-0.003	-0.002	-0.003	-0.002	-0.005	1.000						
PREGNANCY HISTORY – NO HISTORY	-0.039	-0.009	-0.008	-0.005	-0.007	-0.005	-0.014	-0.003	1.000					
PREGNANCY HISTORY – LOW BIRTH WEIGHT	-0.019	-0.011	0.019	0.006	0.007	-0.005	-0.022	-0.007	0.013	1.000				
PREGNANCY HISTORY – PRETERM	0.062	0.002	0.002	0.001	0.011	0.000	0.034	-0.003	0.010	-0.030	1.000			
PREGNANCY HISTORY – LOW BIRTH WEIGHT & PRETERM	0.011	0.008	-0.006	-0.004	0.003	0.000	0.009	0.001	0.000	-0.028	-0.033	1.000		
BMI – UNDERWEIGHT	0.045	0.004	-0.003	-0.002	0.000	0.001	0.010	-0.001	-0.005	0.001	0.009	0.009	1.000	
BMI – OVERWEIGHT	-0.014	-0.003	0.025	0.010	0.005	-0.001	-0.003	-0.006	0.001	0.010	0.031	0.017	-0.185	1.000
FOLIC ACID USE	0.119	0.019	-0.058	-0.020	-0.026	0.004	-0.006	0.010	0.009	-0.022	-0.012	-0.014	-0.028	-0.078
TOBACCO BEFORE PREGNANCY	-0.112	-0.028	0.021	0.009	0.011	-0.013	-0.035	-0.011	-0.019	0.003	0.003	0.023	0.050	0.024
ALCOHOL FREQUENCY BEFORE PREGNANCY	-0.080	0.032	-0.040	-0.014	-0.021	0.003	-0.051	0.013	0.006	-0.034	-0.033	-0.036	-0.016	-0.063
BINGE DRINKING BEFORE PREGNANCY	-0.124	0.015	-0.048	-0.001	-0.028	0.003	-0.065	0.006	0.010	-0.035	-0.030	-0.032	-0.016	-0.029

PROJECT 2 (continued)	**Correlation Matrix**													
	BLACK	AMERICAN INDIAN	CHINESE	JAPANESE	FILIPINO	HAWAIIAN	OTHER NONWHITE	MIXED RACE	PREGNANCY HISTORY NO HISTORY	PREGNANCY HISTORY -LOW BIRTH WEIGHT	PREGNANCY HISTORY PRETERM	PREGNANCY HISTORY -LOW BIRTH WEIGHT & PRETERM	BMI UNDERWEIGHT	BMI OVERWEIGHT
TOBACCO DURING PREGNANCY	-0.046	0.021	-0.029	-0.011	-0.017	-0.004	-0.039	0.012	-0.002	0.026	0.017	0.041	0.046	0.023
ALCOHOL FREQUENCY DURING PREGNANCY	-0.030	-0.008	-0.008	0.004	-0.005	-0.004	-0.002	-0.004	0.017	0.004	-0.005	-0.005	-0.014	-0.047
BINGE DRINKING BEFORE PREGNANCY	-0.023	-0.008	-0.010	0.001	0.001	-0.002	-0.004	-0.003	0.018	-0.001	-0.006	-0.004	-0.011	-0.035
MATERNAL COMPLICATIONS	0.075	0.021	-0.029	-0.011	-0.010	0.003	0.003	0.001	0.005	0.019	0.100	0.097	0.003	0.123
PRENATAL EDUCATION	0.117	0.014	-0.029	-0.023	0.003	0.004	0.027	0.004	0.007	0.021	0.006	0.014	0.006	0.045
PRENATAL CARE INITIATION	0.091	0.014	-0.013	-0.013	-0.005	0.000	0.025	0.008	0.015	0.026	-0.001	-0.002	0.028	0.000

PROJECT 2 (continued)	Correlation Matrix									
	FOLIC ACID	TOBACCO BEFORE PREGNANCY	ALCOHOL FREQUENCY BEFORE PREGNANCY	BINGE DRINKING BEFORE PREGNANCY	TOBACCO DURING PREGNANCY	ALCOHOL FREQUENCY DURING PREGNANCY	BINGE DRINKING DURING PREGNANCY	MATERNAL COMPLICATIONS	PRENATAL EDUCATION	PRENATAL CARE INITIATION
FOLIC ACID USE	1.000									
TOBACCO BEFORE PREGNANCY	-0.207	1.000								
ALCOHOL FREQUENCY BEFORE PREGNANCY	-0.022	0.225	1.000							
BINGE DRINKING BEFORE PREGNANCY	-0.066	0.269	0.780	1.000						
TOBACCO DURING PREGNANCY	-0.157	0.709	0.096	0.136	1.000					
ALCOHOL FREQUENCY DURING PREGNANCY	0.020	0.011	0.294	0.217	0.031	1.000				
BINGE DRINKING DURING PREGNANCY	0.018	0.012	0.246	0.198	0.028	0.779	1.000			
MATERNAL COMPLICATIONS	-0.078	0.096	-0.026	-0.012	0.087	-0.033	-0.024	1.000		
PRENATAL EDUCATION	-0.025	0.055	-0.032	-0.024	0.040	-0.035	-0.030	0.026	1.000	
PRENATAL CARE INITIATION	-0.141	0.058	-0.037	-0.022	0.071	-0.002	-0.008	-0.014	-0.006	1.000

Structural Equation Modeling

Structural equation modeling was conducted to test the conceptual preconception framework and to answer the proposed research questions in this study. The revised preconception framework is a just-identified, or saturated, model, and therefore, exhibits perfect model fit. Thus, the revised analysis plan proceeded with a path analysis of the framework to answer the proposed research questions.

Research Question #1

What is the relationship between preconception health behaviors and adverse pregnancy outcomes among women of reproductive age?

a. To what extent do preconception health behaviors explain the variance associated with adverse pregnancy outcomes?
b. Which factors are most strongly associated with adverse pregnancy outcomes?

To answer these questions, a path analysis was conducted on the reduced framework with data from Project 1. Parameter estimates, measures of error, and measures of statistical significance are presented in Table 15, and the standardized estimates are shown in Figure 8. The R-squared value for this iteration was 0.011. Therefore, preconception health behaviors explained about 1.1% of the variance associated with adverse pregnancy outcomes. Three variables were significantly associated with adverse pregnancy outcomes at the α=.05 level. Among four PRAMS states, the statistically significant variables associated with increased adverse pregnancy outcomes in the reduced preconception framework were as follows:

- Higher BMI for women in the overweight BMI category
- Tobacco use prior to pregnancy
- Talking with a health care provider prior to pregnancy ♦

♦ = Seemingly counterintuitive predictors will be discussed in Chapter 5.

Table 15. Summary of the unstandardized and standardized estimates for the reduced preconception framework in Project 1.

VARIABLES Adverse Pregnancy Outcomes regressed on:	UNSTD. ESTIMATE	STD. ERROR	T-VALUE	TWO-TAILED P-VALUE	STD. ESTIMATE
Maternal BMI – Underweight	0.007	0.004	1.864	0.062	0.023
Maternal BMI – Overweight	0.004	0.001	3.846	0.000	0.049
Folic Acid Use	-0.014	0.011	-1.276	0.202	-0.017
Tobacco Use – Before Pregnancy	0.042	0.011	3.897	0.000	0.059
Alcohol Use – Frequency BeforePregnancy	-0.021	0.021	-1.043	0.297	-0.021
Alcohol Use – Binge Drinking Before Pregnancy	0.010	0.020	0.510	0.610	0.011
Dental Visit Before Pregnancy	-0.029	0.040	-0.735	0.462	-0.009
Talk with Health Care Provider Before Pregnancy	0.209	0.035	6.003	0.000	0.083
Adverse Pregnancy Outcomes $R^2 = 0.011$					

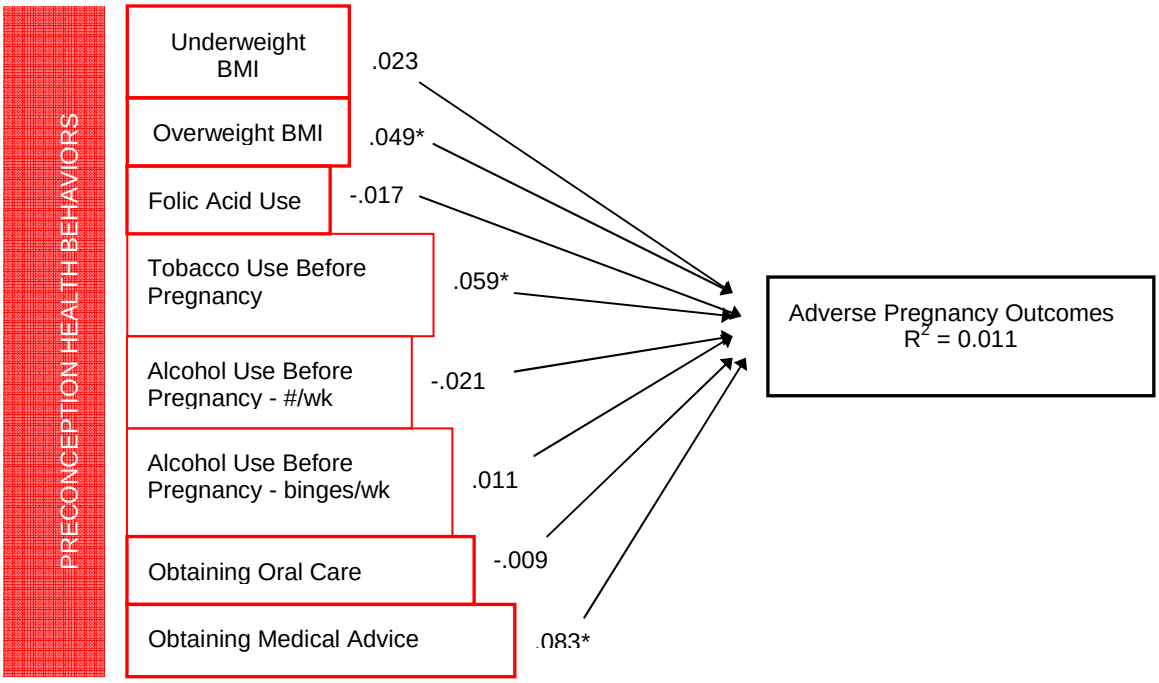


Figure 8. Path analysis with standardized estimates for the reduced preconception framework in Project 1.

To provide further insight into these questions, a path analysis was conducted on the reduced framework with data from Project 2. Parameter estimates, measures of error, and measures of statistical significance are presented in Table 16, and the standardized estimates are depicted in Figure 9. The R-squared value for this iteration was 0.006. Therefore, preconception health behaviors explained about 0.6% of the variance associated with adverse pregnancy outcomes. All variables in the reduced framework were significantly associated with adverse pregnancy outcomes at the α=.05 level. Among all PRAMS-participating states, the statistically significant variables associated with increased adverse pregnancy outcomes in the reduced preconception framework were as follows:

- Higher BMI for women in the underweight BMI category ♦
- Higher BMI for women in the overweight BMI category
- Increased folic acid use ♦
- Tobacco use prior to pregnancy
- Less frequent of alcohol use prior to pregnancy ♦
- Decreased prevalence of binge drinking prior to pregnancy ♦

♦ = Seemingly counterintuitive predictors will be discussed in Chapter 5.

Table 16. Summary of the unstandardized and standardized estimates for the reduced preconception framework in Project 2.

VARIABLES Adverse Pregnancy Outcomes regressed on:	UNSTD. ESTIMATE	STD. ERROR	T-VALUE	TWO-TAILED P-VALUE	STD. ESTIMATE
Maternal BMI – Underweight	0.003	0.001	2.954	0.003	0.010
Maternal BMI – Overweight	0.005	0.000	17.355	0.000	0.065
Folic Acid Use	0.023	0.003	7.022	0.000	0.026
Tobacco Use – Before Pregnancy	0.020	0.003	6.618	0.000	0.026
Alcohol Use - Frequency Before Pregnancy	-0.015	0.006	-2.502	0.012	-0.014
Alcohol Use – Binge Drinking Before Pregnancy	-0.018	0.006	-3.226	0.001	-0.018
Adverse Pregnancy Outcomes $R^2 = 0.006$					

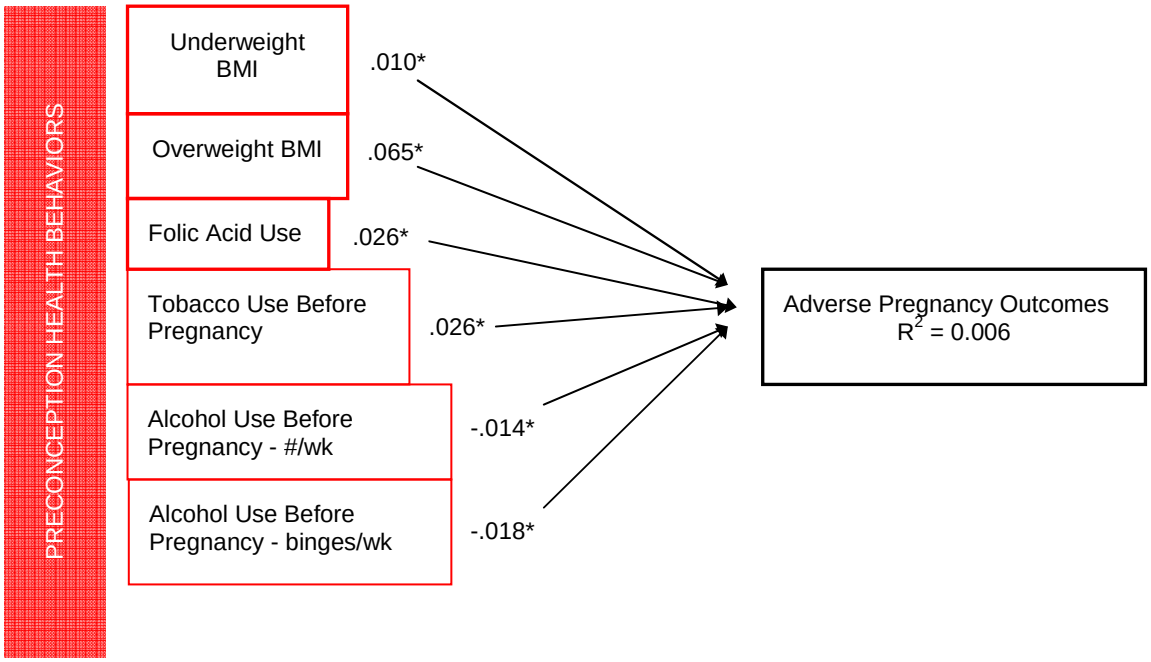


Figure 9. Path analysis with standardized estimates for the reduced preconception framework in Project 2.

Research Question #2

What is the relationship among preconception health behaviors, prenatal factors, postnatal factors, personal influences, environmental factors, and adverse pregnancy outcomes among women of reproductive age?

a. To what extent does the entire framework explain the variance associated with adverse pregnancy outcomes?
b. Which factors are most strongly associated with adverse pregnancy outcomes?

To answer these questions, a path analysis was conducted on the preconception framework with data from Project 1. Parameter estimates, measures of error, and measures of statistical significance are presented in Table 17, and the standardized estimates are shown in Figure 10.

Table 17. Summary of the unstandardized and standardized estimates for the preconception framework in Project 1.

VARIABLES Adverse Pregnancy Outcomes regressed on:	UNSTD. ESTIMATE	STD. ERROR	T-VALUE	TWO-TAILED P-VALUE	STD. ESTIMATE
Insurance status	-0.017	0.036	-0.487	0.626	-0.007
Medicaid	0.068	0.053	1.283	0.199	0.020
Income	-0.005	0.009	-0.586	0.558	-0.011
Maternal Education	-0.016	0.017	-0.983	0.326	-0.015
Stress	0.002	0.009	0.247	0.805	0.004
Physical Abuse	0.073	0.080	0.912	0.362	0.013
Pregnancy Intention – Trying	-0.027	0.043	-0.628	0.530	-0.012
Pregnancy Intention – Timing – Sooner	-0.056	0.035	-1.591	0.112	-0.019
Pregnancy Intention – Timing – Later	-0.047	0.047	-0.995	0.320	-0.019
Pregnancy Intention –	-0.072	0.064	-1.124	0.261	-0.019

Timing – Never					
Maternal Age	0.020	0.004	5.694	0.000	0.100
Hispanic Ethnicity	0.107	0.053	2.008	0.045	0.019
Maternal Race – Other Asian	0.065	0.109	0.599	0.549	0.006
Maternal Race – Black	0.343	0.061	5.598	0.000	0.079
Maternal Race – American Indian	0.220	0.187	1.178	0.239	0.013
Maternal Race – Chinese	-0.055	0.246	-0.225	0.822	-0.003
Maternal Race – Japanese	-0.184	0.144	-1.275	0.202	-0.006
Maternal Race – Filipino	-0.103	0.291	-0.355	0.723	-0.002
Maternal Race – Hawaiian	-0.495	0.145	-3.415	0.001	-0.012
Maternal Race – Other Nonwhite	0.010	0.164	0.059	0.953	0.001
Maternal Race – Mixed Race	0.311	0.183	1.703	0.089	0.021
Pregnancy History – No History	0.371	0.031	11.932	0.000	0.160
Pregnancy History – Low Birth Weight	0.257	0.131	1.967	0.049	0.031
Pregnancy History – Preterm Delivery	0.166	0.083	2.007	0.045	0.028
Pregnancy History – Low Birth Weight and Preterm Delivery	0.737	0.127	5.795	0.000	0.109
Maternal BMI – Underweight	0.003	0.003	0.883	0.377	0.010
Maternal BMI – Overweight	0.000	0.001	-0.044	0.965	-0.001
Folic Acid Use	0.008	0.012	0.712	0.477	0.010
Tobacco Use – Before Pregnancy	0.017	0.014	1.206	0.228	0.023
Alcohol Use – Frequency Before Pregnancy	-0.039	0.020	-1.915	0.055	-0.038
Alcohol Use – Binge Drinking Before Pregnancy	0.015	0.019	0.783	0.434	0.015
Dental Visit Before Pregnancy	0.035	0.039	0.904	0.366	0.011
Talk with Health Care	0.134	0.035	3.874	0.000	0.053

Provider Before Pregnancy					
Tobacco Use – During Pregnancy	0.006	0.022	0.283	0.777	0.006
Alcohol Use – Frequency During Pregnancy	-0.028	0.056	-0.505	0.614	-0.009
Alcohol Use – Binge Drinking During Pregnancy	-0.020	0.062	-0.316	0.752	-0.005
Maternal Complications	0.252	0.013	20.055	0.000	0.281
Prenatal Education	0.002	0.005	0.355	0.722	0.004
Prenatal Care Initiation	0.007	0.003	2.203	0.028	0.029
Adverse Pregnancy Outcomes $R^2 = 0.131$					

The R-squared value for this iteration was 0.131. Therefore, preconception health behaviors explained about 13.1% of the variance associated with adverse pregnancy outcomes. Eleven variables were significantly associated with adverse pregnancy outcomes at the α=.05 level. Among four PRAMS states, the statistically significant variables associated with increased adverse pregnancy outcomes in the preconception framework were as follows:

- Increasing maternal age
- Hispanic ethnicity
- Black participants when compared with white participants
- Talking with a health care provider prior to pregnancy ♦
- Increased maternal complications
- Later prenatal care initiation
- Participants with no previous pregnancies, participants with a previous pregnancy resulting in low birth weight, participants with a previous pregnancy resulting

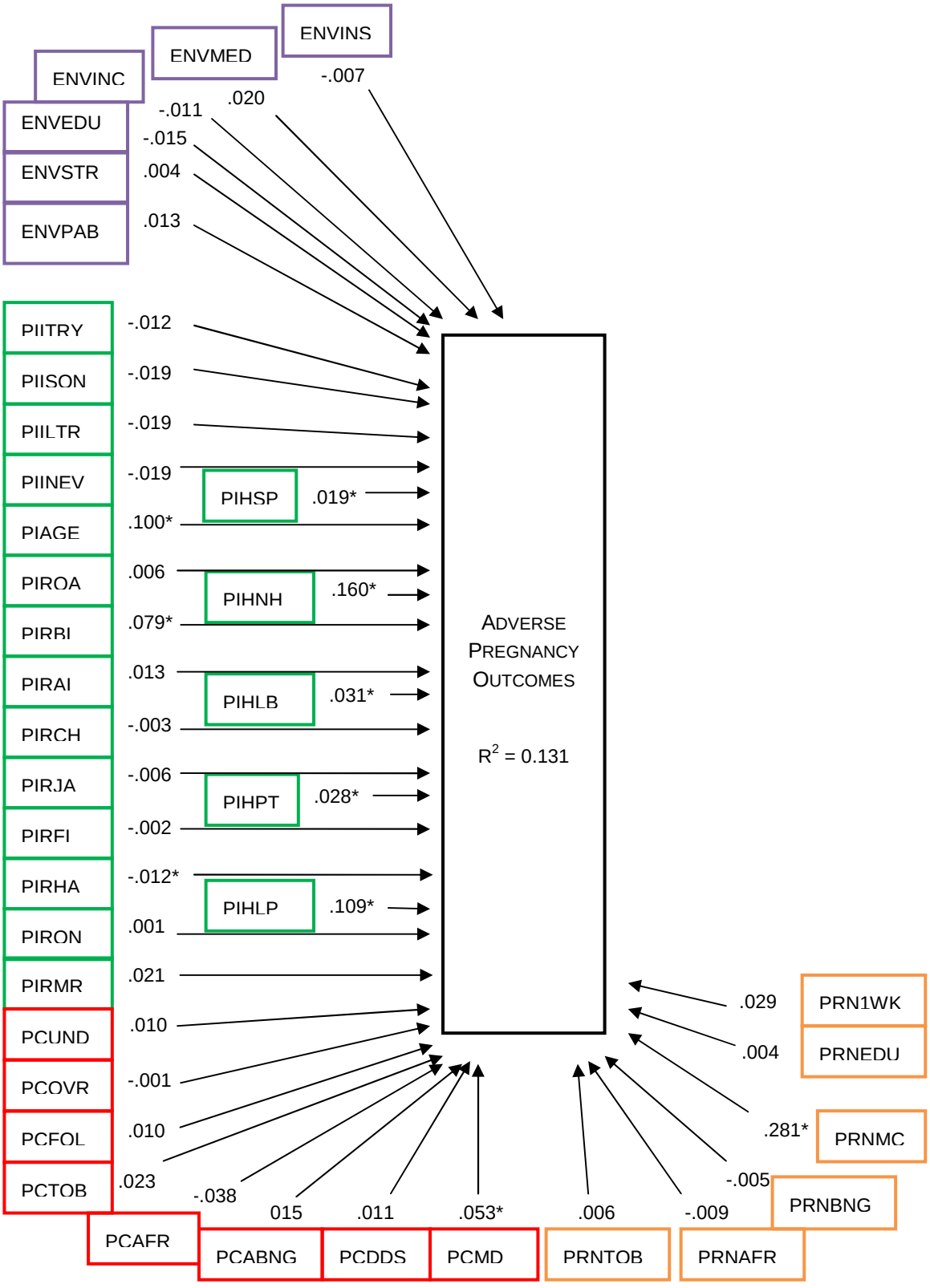


Figure 10. Path analysis with standardized estimates for the preconception framework in Project 1.

Legend for Figure 10:

ENVINS	Insurance status
ENVMED	Medicaid benefits
ENVINC	Income status
ENVEDU	Education level
ENVSTR	External stress
ENVPAB	Physical abuse before pregnancy
PIITRY	Pregnancy intention – trying
PIISON	Pregnancy intention – sooner
PIILTR	Pregnancy intention – later
PIINEV	Pregnancy intention – never
PIAGE	Maternal age
PIHSP	Hispanic ethnicity
PIROA	Maternal race – other Asian
PIRBL	Maternal race – Black
PIRAI	Maternal race – American Indian
PIRCH	Maternal race – Chinese
PIRJA	Maternal race – Japanese
PIRFI	Maternal race – Filipino
PIRHA	Maternal race – Hawaiian
PIRON	Maternal race – other nonwhite
PIRMR	Maternal race – mixed race
PIHNH	Pregnancy history – no history
PIHLB	Pregnancy history – low birth weight
PIHPT	Pregnancy history – preterm delivery
PIHLP	Pregnancy history – low birth weight and preterm delivery
PCUND	Maternal BMI – underweight
PCOVR	Maternal BMI - overweight
PCFOL	Folic acid use
PCTOB	Tobacco use before pregnancy
PCAFR	Alcohol use – frequency before pregnancy
PCABNG	Alcohol use – binge drinking before pregnancy
PCDDS	Dental visit before pregnancy
PCMD	Talk w/ health care provider before pregnancy
PRNTOB	Tobacco use during pregnancy
PRNAFR	Alcohol use – frequency during pregnancy
PRNBNG	Alcohol use – binge drinking during pregnancy
PRNMC	Maternal complications
PRNEDU	Prenatal education
PRN1WK	Prenatal care initiation

in preterm delivery, and participants with a previous pregnancy resulting in low birth weight and preterm delivery when compared to participants with normal previous pregnancy (not associated with low birth weight or preterm delivery)

♦ = Seemingly counterintuitive predictors will be discussed in Chapter 5.

Hawaiian participants were associated with decreased adverse pregnancy outcomes when compared to white participants. For every one standard deviation increase in these eleven variables, there was a corresponding change in adverse pregnancy outcomes that, when measured in standard deviation units, was equal to the standardized estimates provided in Table 17. For example, for every one standard deviation increase in maternal age, there was a 0.100 standard deviation increase in adverse pregnancy outcomes.

The research questions may be further explored in Project 2. The Centers for Disease Control and Prevention (CDC) renamed two variables in the new dataset: 1) the GRAM variable was renamed GRAM_NAPHSIS and 2) the maternal age variable (MAT_AGE) was renamed MAT_AGE_NAPHSIS. A path analysis was conducted on the preconception framework with data from Project 2. Parameter estimates, measures of error, and measures of statistical significance are presented in Table 18, and the standardized estimates are shown in Figure 11. The R-squared value for this iteration was 0.114. Therefore, preconception health behaviors explained about 11.4% of the variance associated with adverse pregnancy outcomes. Twenty-two variables were significantly associated with adverse pregnancy outcomes at the α=.05 level. Among all PRAMS-participating states, the statistically significant variables associated with increased adverse pregnancy outcomes in the preconception framework were as follows:

- Being insured ♦
- Being on Medicaid
- Lower income status
- Lower education
- Fewer external stresses ♦

- Increasing maternal age
- Hispanic ethnicity
- Other Asian, black, Filipino, and Alaskan native participants when compared with white participants
- Higher BMI for women in the overweight category
- Increased folic acid use ♦
- Tobacco use prior to pregnancy
- Less frequent alcohol use prior to pregnancy ♦
- Increasing maternal complications
- Participants with no previous pregnancies, participants with a previous pregnancy resulting in low birth weight, participants with a previous pregnancy resulting in preterm delivery, and participants with a previous pregnancy resulting in low birth weight and preterm delivery when compared with participants with normal previous pregnancy (not associated with low birth weight or preterm delivery)
- Participants wanting to become pregnant sooner and participants not wanting to become pregnant when compared with participants wanting to become pregnant at the time they became pregnant.

♦ = Seemingly counterintuitive predictors will be discussed in Chapter 5

For every one standard deviation increase in these 22 variables, there was a corresponding change in adverse pregnancy outcomes that, when measured in standard deviation units, was equal to the standardized estimates provided in Table 18. For example, for every one standard deviation increase in education level, there was a 0.014 standard deviation decrease in adverse pregnancy outcomes.

Table 18. Summary of the unstandardized and standardized estimates for the preconception framework in Project 2.

VARIABLES Adverse Pregnancy Outcomes regressed on:	UNSTD. ESTIMATE	STD. ERROR	T-VALUE	TWO-TAILED P-VALUE	STD. ESTIMATE
Insurance Status	0.024	0.012	2.043	0.041	0.010
Medicaid Benefits	0.064	0.014	4.514	0.000	0.019
Income	-0.008	0.003	-2.701	0.007	-0.015
Maternal Education	-0.015	0.005	-2.867	0.004	-0.014
External Stress	-0.009	0.003	-3.510	0.000	-0.016
Physical Abuse Before Pregnancy	0.037	0.021	1.797	0.072	0.007
Pregnancy – Trying	0.003	0.012	0.228	0.820	0.001
Pregnancy Intention – Sooner	0.027	0.012	2.305	0.021	0.009
Pregnancy Intention – Later	0.008	0.013	0.607	0.544	0.003
Pregnancy Intention – Never	0.041	0.018	2.259	0.024	0.010
Maternal Age	0.093	0.005	20.466	0.000	0.100
Hispanic Ethnicity	0.073	0.015	4.839	0.000	0.020
Maternal Race – Other Asian	0.108	0.023	4.721	0.000	0.015
Maternal Race – Black	0.287	0.014	21.017	0.000	0.088
Maternal Race – American Indian	0.027	0.030	0.912	0.362	0.002
Maternal Race – Chinese	0.041	0.040	1.012	0.311	0.003
Maternal Race – Japanese	-0.001	0.047	-0.030	0.976	0.000
Maternal Race – Filipino	0.128	0.043	2.978	0.003	0.009
Maternal Race – Hawaiian	-0.051	0.033	-1.565	0.118	-0.002
Maternal Race – Other Nonwhite	-0.034	0.029	-1.184	0.237	-0.004
Maternal Race – Alaskan Native	0.086	0.024	3.635	0.000	0.003
Maternal Race – Mixed Race	0.028	0.051	0.541	0.589	0.002
Pregnancy History – No History	0.367	0.010	38.502	0.000	0.155
Pregnancy History – Low Birth Weight	0.175	0.029	6.009	0.000	0.023
Pregnancy History – Preterm Delivery	0.246	0.025	9.689	0.000	0.039
Pregnancy History – Low Birth Weight & Preterm Delivery	0.642	0.031	20.649	0.000	0.093
Maternal BMI – Underweight	0.001	0.001	0.902	0.367	0.003

Maternal BMI – Overweight	0.002	0.000	7.137	0.000	0.027
Folic Acid Use	0.024	0.003	7.057	0.000	0.028
Tobacco Use Before Pregnancy	0.018	0.004	4.129	0.000	0.023
Alcohol Use – Frequency Before Pregnancy	-0.017	0.006	-2.774	0.006	-0.016
Alcohol Use – Binge Drinking Before Pregnancy	-0.007	0.006	-1.191	0.234	-0.007
Tobacco Use During Pregnancy	-0.011	0.006	-1.833	0.067	-0.009
Alcohol Use – Frequency During Pregnancy	-0.009	0.015	-0.551	0.581	-0.003
Alcohol Use – Binge Drinking During Pregnancy	-0.005	0.016	-0.302	0.762	-0.002
Maternal Complications	0.249	0.004	60.254	0.000	0.263
Prenatal Education	0.001	0.002	0.763	0.445	0.003
Prenatal Care Initiation	0.001	0.001	1.544	0.123	0.006
Adverse Pregnancy Outcomes $R^2 = 0.114$					

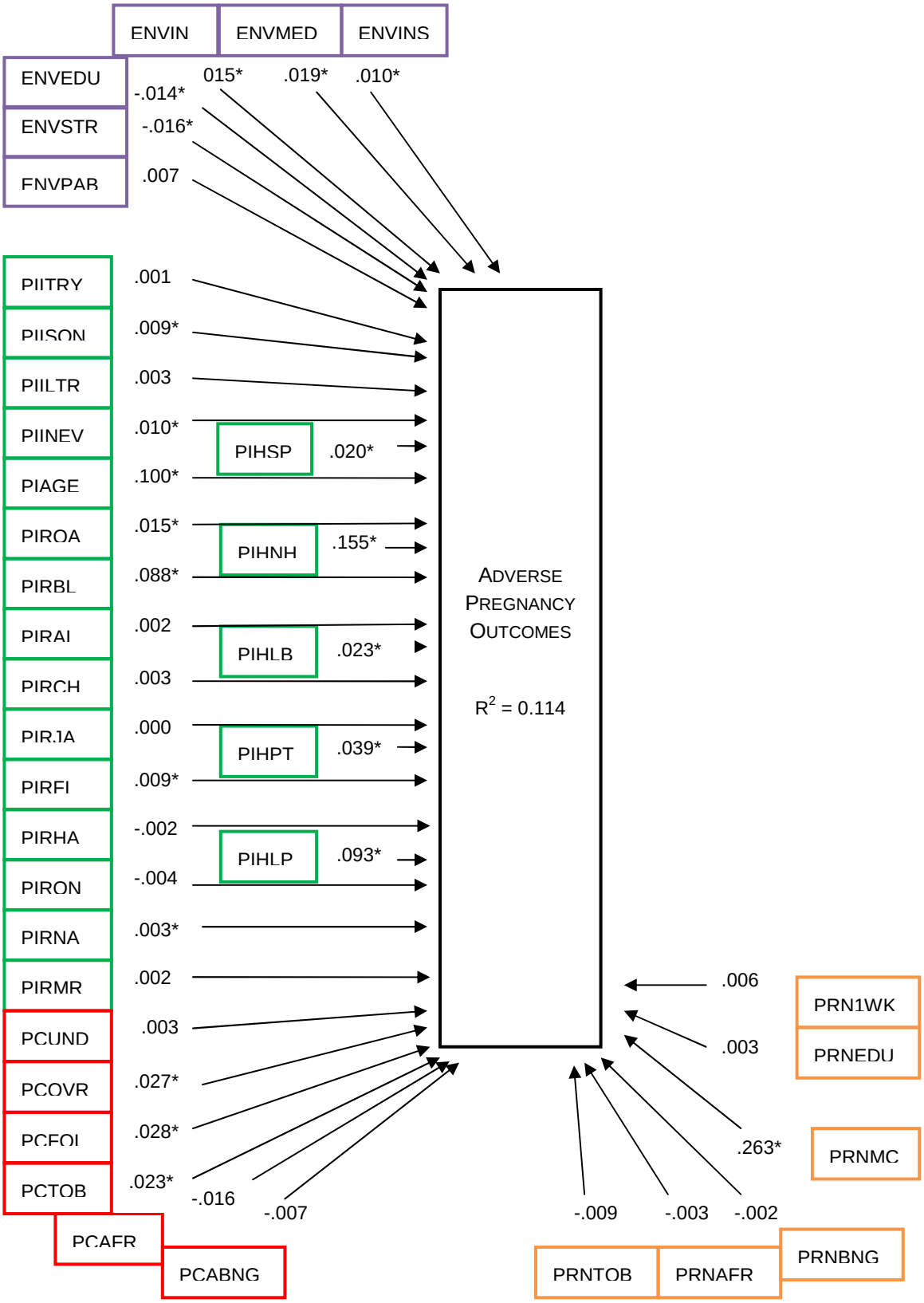


Figure 11. Path analysis with standardized estimates for the preconception framework in Project 2.

Legend for Figure 11

ENVINS	Insurance status
ENVMED	Medicaid benefits
ENVINC	Income status
ENVEDU	Education level
ENVSTR	External stress
ENVPAB	Physical abuse before pregnancy
PIITRY	Pregnancy intention – trying
PIISON	Pregnancy intention – sooner
PIILTR	Pregnancy intention – later
PIINEV	Pregnancy intention – never
PIAGE	Maternal age
PIHSP	Hispanic ethnicity
PIROA	Maternal race – other Asian
PIRBL	Maternal race – Black
PIRAI	Maternal race – American Indian
PIRCH	Maternal race – Chinese
PIRJA	Maternal race – Japanese
PIRFI	Maternal race – Filipino
PIRHA	Maternal race – Hawaiian
PIRON	Maternal race – other nonwhite
PIRNA	Maternal race – Alaskan native
PIRMR	Maternal race – mixed race
PIHNH	Pregnancy history – no history
PIHLB	Pregnancy history – low birth weight
PIHPT	Pregnancy history – preterm delivery
PIHLP	Pregnancy history – low birth weight and preterm delivery
PCUND	Maternal BMI – underweight
PCOVR	Maternal BMI - overweight
PCFOL	Folic acid use
PCTOB	Tobacco use before pregnancy
PCAFR	Alcohol use – frequency before pregnancy
PCABNG	Alcohol use – binge drinking before pregnancy
PRNTOB	Tobacco use during pregnancy
PRNAFR	Alcohol use – frequency during pregnancy
PRNBNG	Alcohol use – binge drinking during pregnancy
PRNMC	Maternal complications
PRNEDU	Prenatal education
PRN1WK	Prenatal care initiation

Due to the relatively low R-squared values in the previous path analyses, the PRAMS dataset was re-examined for additional variables related to adverse pregnancy outcomes that might add insight to the preconception framework. Seven variables related to delivery were added to the framework: 1) vacuum delivery; 2) use of forceps; 3) vaginal birth; 4) vaginal birth after cesarean section; 5) first cesarean section; 6) repeat cesarean section; and 7) plurality. In addition, one environmental factor was added, physical abuse during pregnancy, as well as four prenatal factors: 1) Kessner index (prenatal care classification developed by the Institutes of Medicine in 1973 that adjusts the timing and quantity of prenatal care for the length of gestation to determine levels of adequate, inadequate, and intermediate prenatal care); 2) number of prenatal care visits; 3) hospitalization during pregnancy; and 4) maternal weight gain during pregnancy. Also, a variable regarding birth defects was added to the adverse pregnancy outcomes variable. Univariate characteristics and bivariate correlations for these variables are included in Appendices B and C respectively. A path analysis was conducted on the preconception framework with extra variables from the second dataset. Parameter estimates, measures of error, and measures of statistical significance are presented in Table 19, and the standardized estimates are depicted in Figure 12. The R-squared value for this iteration was 0.305. Therefore, the preconception health framework explained about 30.5% of the variance associated with adverse pregnancy outcomes. Twenty-seven variables were significantly associated with adverse pregnancy outcomes at the α=.05 level. Among all PRAMS-participating states, the statistically significant variables associated with increased adverse pregnancy outcomes in the preconception framework were as follows:

- Receiving Medicaid benefits
- Less income
- Fewer external stresses ♦

- Increasing maternal age
- Hispanic ethnicity
- Other Asian, black, Chinese, Filipino, and Alaskan native participants when compared with white participants
- Higher BMI for women in the underweight category ♦
- Lower BMI for women in the overweight category ♦
- Increased folic acid use ♦
- Tobacco use prior to pregnancy
- Less maternal weight gain during pregnancy ♦
- Increasing hospitalization during pregnancy
- Increasing maternal complications
- Toward adequate on the Kessner Index ♦
- Fewer prenatal care visits
- Multiple gestation
- First cesarean section
- Repeated cesarean section
- Participants with no previous pregnancies, participants with a previous pregnancy resulting in low birth weight, participants with a previous pregnancy resulting in preterm delivery, and participants with a previous pregnancy resulting in low birth weight and preterm delivery when compared with participants with normal previous pregnancy (not associated with low birth weight or preterm delivery)
- Participants not wanting to become pregnant were associated with increased adverse pregnancy outcomes when compared to participants wanting to become pregnant at the time they became pregnant.

♦ = Seemingly counterintuitive predictors will be discussed in Chapter 5.

For every one standard deviation increase in these 27 variables, there was a corresponding change in adverse pregnancy outcomes that, when measured in standard deviation units, was equal to the standardized estimates provided in Table 19. For example, for every one standard deviation increase in plurality, there was a 1.457 standard deviation increase in adverse pregnancy outcomes.

Table 19. Summary of the unstandardized and standardized estimates for the post hoc analysis of the preconception framework.

VARIABLES Adverse Pregnancy Outcomes regressed on:	UNSTD. ESTIMATE	STD. ERROR	T-VALUE	TWO-TAILED P-VALUE	STD. ESTIMATE
Insurance Status	0.012	0.012	1.055	0.291	0.005
Medicaid Benefits	0.050	0.014	3.449	0.001	0.014
Income	-0.007	0.003	-2.421	0.015	-0.013
Maternal Education	-0.006	0.005	-1.169	0.242	-0.006
External Stress	-0.006	0.003	-2.172	0.030	-0.010
Physical Abuse – Before Pregnancy	0.006	0.024	0.267	0.790	0.001
Physical Abuse – During Pregnancy	0.057	0.030	1.911	0.056	0.009
Pregnancy – Trying	0.004	0.012	0.287	0.774	0.001
Pregnancy Intention – Sooner	-0.004	0.012	-0.365	0.715	-0.001
Pregnancy Intention – Later	0.014	0.013	1.052	0.293	0.005
Pregnancy Intention – Never	0.048	0.018	2.662	0.008	0.012
Maternal Age	0.043	0.005	9.355	0.000	0.046
Hispanic Ethnicity	0.056	0.015	3.688	0.000	0.015
Maternal Race – Other Asian	0.094	0.023	4.100	0.000	0.013
Maternal Race – Black	0.205	0.014	14.965	0.000	0.062
Maternal Race – American Indian	-0.015	0.033	-0.467	0.641	-0.001
Maternal Race – Chinese	0.075	0.038	1.980	0.048	0.005
Maternal Race – Japanese	0.071	0.048	1.487	0.137	0.003
Maternal Race – Filipino	0.106	0.041	2.614	0.009	0.007
Maternal Race – Hawaiian	0.003	0.031	0.090	0.928	0.000

Maternal Race – Other Nonwhite	-0.033	0.029	-1.133	0.257	-0.004
Maternal Race – Alaskan Native	0.145	0.025	5.858	0.000	0.004
Maternal Race – Mixed Race	-0.031	0.055	-0.560	0.575	-0.002
Pregnancy History – No History	0.240	0.010	24.192	0.000	0.101
Pregnancy History – Low Birth Weight	0.137	0.028	4.844	0.000	0.018
Pregnancy History – Preterm Delivery	0.180	0.025	7.143	0.000	0.028
Pregnancy History – Low Birth Weight & Preterm Delivery	0.437	0.031	14.264	0.000	0.063
Maternal BMI – Underweight	0.003	0.001	3.007	0.003	0.010
Maternal BMI – Overweight	-0.001	0.000	-4.165	0.000	-0.016
Folic Acid Use	0.011	0.003	3.356	0.001	0.013
Tobacco Use Before Pregnancy	0.011	0.004	2.438	0.015	0.014
Alcohol Use – Frequency Before Pregnancy	-0.008	0.006	-1.279	0.201	-0.007
Alcohol Use – Binge Drinking Before Pregnancy	-0.009	0.005	-1.732	0.083	-0.009
Tobacco Use During Pregnancy	-0.011	0.006	-1.699	0.089	-0.009
Alcohol Use – Frequency During Pregnancy	0.002	0.015	0.137	0.891	0.001
Alcohol Use – Binge Drinking During Pregnancy	-0.005	0.016	-0.309	0.757	-0.002
Maternal Weight Gain During Pregnancy	-0.003	0.000	-9.808	0.000	-0.037
Hospitalization During Pregnancy	0.768	0.018	43.070	0.000	0.215
Maternal Complications	0.134	0.004	32.274	0.000	0.142
Kessner Index	0.108	0.011	9.679	0.000	0.050
Prenatal Education	0.000	0.002	0.313	0.754	0.001
Number of Prenatal Care Visits	-0.197	0.008	-26.206	0.000	-0.125
Prenatal Care Initiation	0.002	0.001	1.733	0.083	0.007
Plurality	1.457	0.039	37.132	0.000	0.173
First Cesarean Section	0.879	0.056	15.630	0.000	0.292
Forceps Delivery	0.014	0.035	0.398	0.691	0.001

Repeated Cesarean Section	0.618	0.057	10.913	0.000	0.168
Vacuum Delivery	-0.007	0.021	-0.351	0.725	-0.001
Vaginal Delivery	0.016	0.055	0.287	0.774	0.006
Vaginal Delivery After Cesarean Section	0.066	0.061	1.087	0.277	0.006
Adverse Pregnancy Outcomes $R^2 = 0.305$					

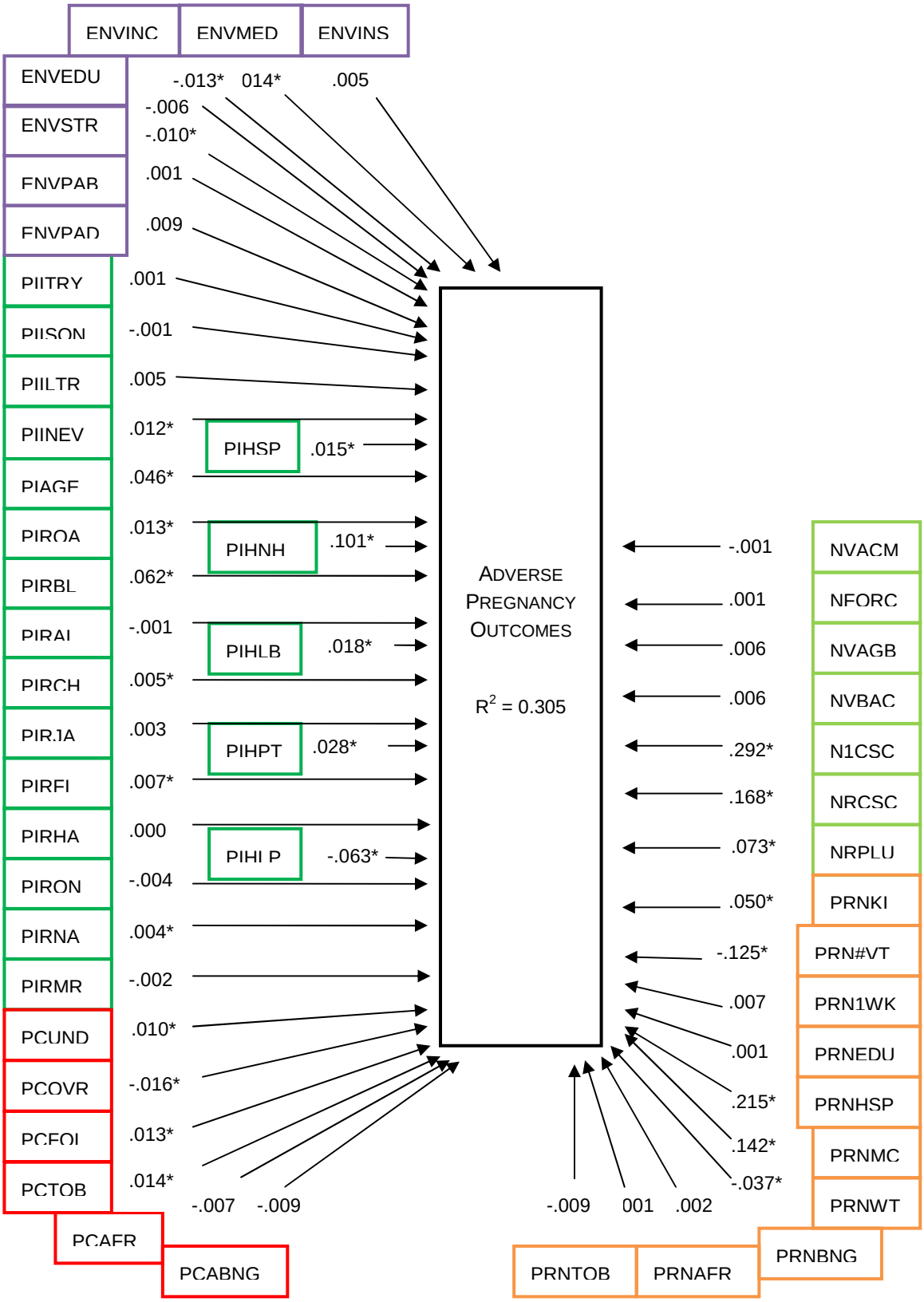


Figure 12. Path analysis with standardized estimates for the post hoc analysis of the preconception framework.

Legend for Figure 12:

ENVINS	Insurance status
ENVMED	Medicaid benefits
ENVINC	Income status
ENVEDU	Education level
ENVSTR	External stress
ENVPAB	Physical abuse before pregnancy
ENVPAD	Physical abuse during pregnancy
PIITRY	Pregnancy intention – trying
PIISON	Pregnancy intention – sooner
PIILTR	Pregnancy intention – later
PIINEV	Pregnancy intention – never
PIAGE	Maternal age
PIHSP	Hispanic ethnicity
PIROA	Maternal race – other Asian
PIRBL	Maternal race – Black
PIRAI	Maternal race – American Indian
PIRCH	Maternal race – Chinese
PIRJA	Maternal race – Japanese
PIRFI	Maternal race – Filipino
PIRHA	Maternal race – Hawaiian
PIRON	Maternal race – other nonwhite
PIRNA	Maternal race – Alaskan native
PIRMR	Maternal race – mixed race
PIHNH	Pregnancy history – no history
PIHLB	Pregnancy history – low birth weight
PIHPT	Pregnancy history – preterm delivery
PIHLP	Pregnancy history – low birth weight and preterm delivery
PCUND	Maternal BMI – underweight
PCOVR	Maternal BMI - overweight
PCFOL	Folic acid use
PCTOB	Tobacco use before pregnancy
PCAFR	Alcohol use – frequency before pregnancy
PCABNG	Alcohol use – binge drinking before pregnancy
PRNTOB	Tobacco use during pregnancy
PRNAFR	Alcohol use – frequency during pregnancy
PRNBNG	Alcohol use – binge drinking during pregnancy
PRNWT	Maternal weight gain while pregnant
PRNMC	Maternal complications
PRNHSP	Hospitalized during pregnancy
PRNEDU	Prenatal education
PRN1WK	Prenatal care initiation
PRN#VT	Number of prenatal care visits
PRNKI	Kessner Index
NRPLU	Plurality
NRCSC	Repeated cesarean section
N1CSC	First cesarean section
NVBAC	Vaginal birth after cesarean section
NVAGB	Vaginal delivery
NFORC	Forceps delivery
NVACM	Vacuum delivery

A summary view comparing the statistically significant variables associated with these five framework iterations is presented in Table 20.

Table 20. Summary of statistically significant variables associated with the preconception framework iterations.

	Project 1 Reduced Framework	Project 2 Reduced Framework	Project 1 Full Framework	Project 2 Full Framework	Dataset 2 Full Framework Post hoc Analysis
Sample Size	12,239	128,551	12,239	128,551	112,675
% Variance Accounted For	1.1%	0.6%	13.1%	11.4%	30.5%
VARIABLES					
ENVIRONMENTAL FACTORS					
Insurance Status	X	X		+	
Medicaid Benefits	X	X		+	+
Income	X	X		-	-
Maternal Education	X	X		-	
External Stress	X	X		-	-
Physical Abuse – Prior to Pregnancy	X	X			
Physical Abuse – During Pregnancy	X	X	X	X	
PERSONAL INFLUENCES					
Pregnancy – Trying	X	X			
Pregnancy Intention– Timing - Sooner	X	X		+	
Pregnancy Intention – Timing - Later	X	X			
Pregnancy Intention – Timing - Never	X	X		+	+
Maternal Age	X	X	+	+	+
Hispanic Ethnicity	X	X	+	+	+
Maternal Race – Other Asian	X	X		+	+
Maternal Race – Black	X	X	+	+	+
Maternal Race – American Indian	X	X			
Maternal Race – Chinese	X	X			+
Maternal Race – Japanese	X	X			
Maternal Race – Filipino	X	X		+	+
Maternal Race – Hawaiian	X	X	-		
Maternal Race – Other Nonwhite	X	X			
Maternal Race – Alaskan Native	X	X		+	+

Maternal Race – Mixed Race	X	X			
Pregnancy History – No History	X	X	+	+	+
Pregnancy History – Low Birth Weight	X	X	+	+	+
Pregnancy History – Preterm Delivery	X	X	+	+	+
Pregnancy History – Low Birth Weight & Preterm Delivery	X	X	+	+	+
PRECONCEPTION HEALTH BEHAVIORS					
Maternal BMI – Underweight		+			+
Maternal BMI – Overweight	+	+		+	-
Folic Acid Use		+		+	+
Tobacco Use Before Pregnancy	+	+		+	+
Alcohol Use – Frequency Before Pregnancy		-		-	
Alcohol Use – Binge Drinking Before Pregnancy		-			
Dental Visit Before Pregnancy		X		X	X
Talk with Health Care Provider Before Pregnancy	+	X	+	X	X
PRENATAL FACTORS					
Tobacco Use During Pregnancy	X	X			
Alcohol Use – Frequency During Pregnancy	X	X			
Alcohol Use – Binge Drinking During Pregnancy	X	X			
Maternal Complications	X	X	+	+	+
Hospitalization During Pregnancy	X	X	X	X	+
Prenatal Education	X	X			
Prenatal Care Initiation	X	X	+		
Kessner Index	X	X	X	X	+
# of Prenatal Care Visits	X	X	X	X	-
Maternal Weight Gain During Pregnancy	X	X	X	X	-
NATAL FACTORS					
Plurality	X	X	X	X	+
First Cesarean Section	X	X	X	X	+
Forceps Delivery	X	X	X	X	
Repeated Cesarean Section	X	X	X	X	+
Vacuum Delivery	X	X	X	X	
Vaginal Delivery	X	X	X	X	
Vaginal Delivery After	X	X	X	X	

Cesarean Section					

Shaded cell = Demonstrated statistical significance; X = Variable not applicable for framework iteration; +/- = Sign associated with significance (+ = increase/ - = decrease in adverse pregnancy outcomes when variable experiences an increase).

Sub-Analysis

In the analysis plan, sub-analyses were to be conducted to account for recall bias, differences between early and late responders, and the impact of response waves. Due to PRAMS privacy limitations, the impact of recall bias was not assessed. As a proxy for difference detection among early and late responders, as well as detection of differences in response waves, a sub-analysis was conducted regarding mode of participation. The mode of participation variable categorizes participants by mail or telephone response. According to study protocol, PRAMS surveys are primarily distributed via mail. Only those participants failing to respond to a third mailing are contacted by telephone to complete the survey via telephone. Therefore, participants categorized as telephone mode of participation are also indicative of late response and are among the last wave of responders in relation to survey initiation date. Due to the uneven sample sizes between mail and telephone participants, the frequency percentages are shown in Table 21 for Projects 1 and 2.

To determine differences between the two groups, the Rao-Scott modified chi square test was conducted regarding categorical variables, and unweighted two sample t-tests (Satterthwaite method reported) were conducted regarding continuous variables. In Project 1, participants responding by mail differed from participants responding by telephone with respect to the following demographic characteristics: maternal age [t (7,957) = 16.68, p <0.0001], maternal education [X^2 = 139.11, df = 4, p<.0001], being

insured [X^2 = 74.94, df = 1, p<.0001], receiving Medicaid benefits [X^2 = 33.36, df = 1, p<.0001], Hispanic ethnicity [X^2 = 29.13, df = 1, p<.0001], black maternal race [X^2 =

Table 21. Mode of participation frequency for Projects 1 and 2.

Infant Mortality[a]	**Project 1 (Frequency Percentages)**		**Project 2 (Frequency Percentages)**	
Variables	**Mail (N=10,858)**	**Telephone (N=1,381)**	**Mail (N=106,199)**	**Telephone (N=22,352)**
AGE				
17 years of age or younger	1.2	3.6	1.7	3.4
18 to 19 years	5.1	10.6	5.2	8.3
20 to 24 years	25.2	33.8	22.1	31.1
25 to 29 years	33.4	30.4	30.0	27.3
30 to 34 years	23.3	14.0	25.7	18.9
35 to 39 years	10.0	5.6	12.7	8.9
40 years of age or older	1.8	2.0	2.7	2.0
RACE/ETHNICITY				
HISPANIC				
Yes	3.7	8.1	10.1	17.9
No	96.3	91.9	89.9	82.1
RACE/ETHNICITY				
Other Asian	1.2	0.8	2.6	2.5
White	90.8	73.2	79.2	60.0
Black	5.4	20.6	12.4	30.1
American Indian	0.4	0.9	0.9	1.1
Chinese	0.3	0.2	0.8	0.3
Japanese	0.1	0.0	0.3	0.1
Filipino	0.0	0.0	0.7	0.6
Hawaiian	0.1	0.0	0.3	0.4
Other Nonwhite	1.0	3.2	1.9	3.8
Alaskan Native	0.0	0.0	0.1	0.2
Mixed Race	0.5	1.2	0.8	1.1

INSURANCE STATUS (excludes Medicaid)				
Insured	72.3	52.8	68.7	49.7
Not insured	27.7	47.2	31.3	50.3
MEDICAID STATUS				
Enrolled in Medicaid	11.2	21.0	10.8	24.5
Not enrolled in Medicaid	88.8	79.0	89.2	75.5
INCOME LEVEL				
Less than $10,000	12.6	25.4	15.4	25.9
$10,000 to $14,999	7.9	11.8	7.9	11.8
$15,000 to $19,999	5.1	9.5	5.8	9.2
$20,000 to $24,999	7.2	9.1	6.9	8.8
$25,000 to $34,999	12.5	14.6	10.1	11.4
$35,000 to $49,999	14.7	10.5	11.3	9.7
$50,000 or more	39.9	19.1	42.6	23.3
EDUCATION LEVEL				
0-8 years	1.1	1.8	2.0	4.1
9-11 years	7.0	16.9	9.0	17.8
12 years	28.2	41.4	26.5	36.6
13-15 years	29.3	25.2	25.6	24.0
16 years or more	34.4	14.7	36.8	17.5

[a] Missing data not shown; percentages may not equal 100% due to rounding.

151.01, df = 1, p<.0001] and other nonwhite maternal race [X^2 = 9.14, df = 1, p = .003]. The groups did not differ with respect to other Asian maternal race [X^2 = 1.85, df = 1, p = 0.17], American Indian maternal race [X^2 = 2.71, df = 1, p = 0.10], Chinese maternal race [X^2 = 0.97, df = 1, p = 0.33], Filipino maternal race [X^2 = 0.03, df = 1, p = 0.87], mixed maternal race [X^2 = 2.05, df = 1, p = 0.15]. Also in Project 1, participants responding by mail differed from participants responding by telephone with respect to the following

selected variables: adverse pregnancy outcomes [t (7,705) = -10.96, p=0.04], talking with a health care provider before pregnancy [X^2 = 12.40, df = 1, p = .0004], folic acid use [X^2 = 16.12, df = 3, p = .001], and tobacco use before pregnancy [X^2 = 29.18, df = 6, p<.0001]. The groups did not differ with respect to dental visit before pregnancy [X^2 = 1.55, df = 1, p = 0.21], alcohol frequency before pregnancy [X^2 = 5.27, df = 5, p = 0.38], and binge drinking before pregnancy [X^2 = 9.58, df = 5, p = 0.09].

In Project 2, participants included in the study differed from participants excluded from the study with respect to the following demographic characteristics: maternal age [t (61,614) = 57.48, p <.0001], maternal education [X^2 = 1,597.85, df = 4, p<.0001], being insured [X^2 = 1,070.74, df = 1, p<.0001], receiving Medicaid benefits [X^2 = 1,096.13, df = 1, p<.0001], and Hispanic ethnicity [X^2 = 407.56, df = 1, p<.0001]. The two groups differed according to the following maternal race categories: black [X^2 = 1,663.48, df = 1, p<.0001], American Indian maternal race [X^2 = 7.16, df = 1, p = 0.01], Chinese maternal race [X^2 = 60.22, df = 1, p<.0001], Japanese maternal race [X^2 = 39.65, df = 1, p<.0001], Hawaiian maternal race [X^2 = 29.72, df = 1, p<0001], other nonwhite [X^2 = 114.52, df = 1, p<.0001], Alaskan native [X^2 = 243.05, df = 1, p<.0001], and mixed maternal race [X^2 = 6.47, df = 1, p = 0.01]. The groups did not differ with respect to other Asian maternal race [X^2 = 0.18, df = 1, p = 0.67] or Filipino maternal race [X^2 = 0.45, df = 1, p = 0.50]. Also in Project 2, participants responding by mail differed from participants responding by telephone with respect to the following selected variables: adverse pregnancy outcomes [t (53,640) = -15.52, p <.0001], folic acid use [X^2 = 314.77, df = 3, p<.0001], tobacco use before pregnancy [X^2 = 148.58, df = 6, p<.0001], alcohol frequency before pregnancy [X^2 = 824.83, df = 5, p<.0001], and binge drinking before pregnancy [X^2 = 1,070.66, df = 5, p<.0001]. In both projects, participants responding by telephone were younger, more racially diverse (more identified as black and other racial categories; more identified as Hispanic ethnicity), uninsured, receiving Medicaid, with

lower income levels, and with less education. These differences will be discussed at greater length in the next chapter.

Chapter 5: Discussion

This chapter explores the impact of preconception health on adverse pregnancy outcomes through the theoretical lens of reciprocal determinism. It includes the following sections: research summary, discussion of results, strengths and limitations of the study, implications for future research, implications for public health practice, suggestions for dissemination of the findings, and a summary of the conclusions.

Research Summary

Research indicates that prenatal care alone is insufficient to effect necessary change in infant mortality, thus explicating the need for other prevention strategies, such as preconception care (DHHS, 2000; Korenbrot, Steinberg, Bender, & Newberry, 2002). The idea of preconception health derives from ancient times and it is not a new idea. Yet, preconception health is only now being considered as supplemental prevention to prenatal care in the United States (Atrash, 2008). Preconception health, however, does not occur in a vacuum. The literature fails to demonstrate the effectiveness of preconception health as a whole on reducing adverse pregnancy outcomes, especially in the context of environmental and personal influences. The preconception framework may help explain the impact of preconception health on adverse pregnancy outcomes in a broader context. The purpose of this study was to examine the impact of preconception health on adverse pregnancy outcomes, with and without the influence of extenuating factors, such as environmental factors, personal influences, prenatal factors, and postnatal factors. Project 1 of this study included four PRAMS-participating states that administered two optional survey items related to oral health care and medical health care prior to pregnancy in their PRAMS surveys (original N = 27,933). Project 2

of this study included 32 PRAMS-participating states and one city (original N = 200,008). For each project, the preconception framework was examined with preconception health factors alone (reduced framework), in its entirety (the preconception framework), and with additional post hoc factors. Structural equation modeling was used to examine the multiple iterations of the preconception framework.

Discussion of Results

The research questions posed in this study were resolved through the path analyses of the reduced and full preconception frameworks in Projects 1 and 2. The analysis of the reduced frameworks for both projects revealed extremely low R-squared values (1.1% or less). Therefore, it was concluded that preconception health behaviors alone account for a negligible portion of the variance in adverse pregnancy outcomes. According to the principle of reciprocal determinism, preconception health behaviors interact with environmental factors and personal influences. Thus, the subsequent analyses examined the full framework in Projects 1 and 2, as well as an additional post hoc analysis with supplementary PRAMS variables. In these analyses, certain variables emerged as stronger predictors of adverse pregnancy outcomes than others.

Environmental factors. According to the literature, adverse pregnancy outcomes are often linked with lower socioeconomic status (Dobie, et al., 1998; Howell, et al., 1991; Krieger, Connell, & LoGerfo, 1992; Liu, et al., 2010; Matijasevich, et al., 2010; Schwethelm, Margolis, Miller, & Smith, 1989; Snyder, 2004). In this study, receiving Medicaid benefits, having less income, and having lower maternal education were associated with increased adverse pregnancy outcomes. However, the results of this study also demonstrate that being insured was associated with increased adverse pregnancy outcomes, and being exposed to more external stresses (e.g., moving, divorce, loss of employment, death of another) was associated with decreased adverse pregnancy outcomes. These results seem counterintuitive; possible explanations for

these unexpected results are presented below.

The average cost for a vaginal delivery with a maternal and infant hospital stay of two days is $5,992 (Healthcare Blue Book, 2011). The average cost for a cesarean section delivery with a maternal hospital stay of four days is $8,558 (Healthcare Blue Book). Each additional day charge is $1,800 for the mother and $335 for the baby, and these costs do not include the possible use of the neonatal intensive care unit (Healthcare Blue Book). Hospital costs associated with delivery may be prohibitive for uninsured women. Most federal and state legislation requires insurance plans to cover postpartum hospital stays of ≥48 hours for vaginal deliveries and ≥72 or 96 hours for cesarean sections (Datar & Sood, 2006; Liu, Dow, & Norton, 2004). It is possible that insured participants take advantage of longer maternal hospital stays than uninsured participants, and a maternal hospital stay of four days or more was categorized as an adverse pregnancy outcome in this study. Thus, longer maternal hospital stays among insured women may account for the association with increased adverse pregnancy outcomes in this study. Also, insurance status may be associated with cases of in vitro fertilization which in turn are associated with increased adverse pregnancy outcomes. In vitro fertilization has been associated with increased risk of maternal complications such as preeclampsia, gestational hypertension, placental abruption, placenta previa, risk of cesarean section, as well as adverse pregnancy outcomes such as preterm delivery, low birth weight, and neonatal intensive care admission (Jackson, Gibson, Wu, & Croughan, 2004; Shevell, et al., 2005). Thus, insurance status may lead to increased adverse pregnancy outcomes via the use of in vitro fertilization. In addition, there is an association between being privately insured and increased rates of cesarean section (Murray, 2000). Delivery by cesarean section may be performed in cases of placental abnormalities, maternal infections, plurality, fetal distress, certain birth defects, and maternal distress (March of Dimes, 2008). These conditions often result in the adverse

pregnancy outcomes associated with this study: preterm delivery, low birth weight, small for gestational age, use of the neonatal intensive care unit, longer infant hospital stay, longer maternal hospital stay, and infant mortality (March of Dimes, 2008). Thus, as indicated in this study, being insured may be associated with increased adverse pregnancy outcomes due to lengthier hospitalization, use of in vitro fertilization, and increased cesarean section deliveries, a statistical artifact so to speak.

Stress during pregnancy has been associated with increased risk of preterm delivery and small for gestational age (Hobel, Goldstein, & Barrett, 2008). However, these associations are inconsistent due to limitations in stress scales, associations with smoking, and associations only evident among subgroups (Dole, et al., 2008; Harville, et al., 2010; Neggers, et al., 2006; St-Laurent, et al., 2008). Stress may be segmented into pregnancy-related stress, anxiety state, perceived stress, and life event stress (Lynn, et al., 2010). Pregnancy-related stress may include physical or physiological changes during pregnancy, concerns about labor and delivery, concerns about the health of the fetus, or concerns about parenting (Lynn, et al., 2010; Stanton, et al., 2002). This type of stress is considered to be a better predictor of adverse pregnancy outcomes compared to other measures, like anxiety state, perceived stress, and life event stress (Dole, et al., 2003; Huizink, et al., 2004; Lobel, et al., 2008; Lynn, et al., 2010; O'Connor, et al., 2002). In the PRAMS data used in this study, the total number of stresses was based upon life event stress, such as loss of employment, change of residence, divorce, death of another, family illness, and homelessness. In this study, increased life event stress was associated with decreased adverse pregnancy outcomes. Accordingly, if pregnancy-related stress had been included in this study as opposed to life event stress, it is possible that there would have been the expected association between more stress and increased adverse pregnancy outcomes supported by the literature. Another possible explanation for the unexpected finding in this study is

a woman's reactivity to stress during pregnancy. Previous studies have demonstrated that women become less reactive physiologically and psychologically to external stress exposure as a pregnancy progresses (deWeerth & Buitelaar, 2005; Glynn, et al., 2004). After inducing the same stress among pregnant women at two points in time, study participants had significantly lower heart rate, blood pressure, and psychological distress at the second assessment (31 weeks gestation) compared to the first assessment at 17 weeks gestation (deWeerth & Buitelaar, 2005). Thus, later gestational timing of stress exposure results in less physiologic reactivity (deWeerth & Buitelaar). This attenuation of reactivity may account for the association between increased stress during pregnancy and decreased adverse pregnancy outcomes, but the timing of the stress exposures in this study is unknown.

Personal influences. Older maternal age is often associated with increased adverse pregnancy outcomes (Bell, et al., 2001; Buescher & Mittal, 2006; Lisonkova, et al., 2010; Martin, et al., 2002; Prysak, et al., 1995; Seoud, et al., 2002; Vercellini, et al., 1993; Ziadeh, 2002), and this association was present in all possible iterations in this study. Hispanic ethnicity also impacts adverse pregnancy outcomes. The Latina paradox suggests that Latina women, especially Mexican-born women, experience more favorable birth outcomes than non-Hispanic women with similar socioeconomic profiles (Hummer, et al., 2007; McGlade, Saha, & Dahlstrom, 2004). Puerto Rican Black women have been shown to experience more favorable birth outcomes than non-Hispanic blacks (Reichman & Kenney, 1998). However, Puerto Rican white women have been shown to experience higher rates of low birth weight babies and infant mortality when compared to non-Hispanic white women (Mathews & MacDorman, 2007; Reichman & Kenney, 1998). In opposition to the paradox, Hispanic ethnicity was associated with increased adverse pregnancy outcomes in all possible iterations of the study. However, the impact of race or country of origin was not ascertained in this study.

Maternal race also impacts adverse pregnancy outcomes. Black maternal race, when compared to white maternal race, was associated with increased adverse pregnancy outcomes in all possible iterations of this study. This coincides with the black-white infant mortality gap demonstrated in the literature. Weathering, or early health deterioration due to social inequality, may account for this racially biased outcome (Geronimus, 1996). However, after controlling for socioeconomic status, African American infants continue to experience increased infant mortality rates, increased rates of very preterm delivery and preterm delivery, and increased rates of very low birth weight and low birth weight compared to white Americans (Buescher & Mittal, 2006; Dominguez, et al., 2005; Dunlop, et al., 2008; Iyasu, et al., 1992; Lu & Halfon, 2003; Paneth, 1995; Singh & Yu, 1995; Ward, et al., 2010). In addition, Other Asian, Chinese, and Filipino maternal races were associated with increased adverse pregnancy outcomes, and Hawaiian maternal race was associated with decreased adverse pregnancy outcomes when compared to white maternal race in this study. According to the literature, Asians and Pacific Islanders (including Hawaiians) have lower rates of infant mortality and preterm birth compared to non-Hispanic whites and non-Hispanic blacks (Institute of Medicine, 2007; Kieffer, Mor, & Alexander, 1996; Mathews & MacDorman, 2007). This study partially corroborates these findings.

Pregnancy intention also impacts adverse pregnancy outcomes. Pregnancy intention is difficult to measure, because maternal response may fluctuate depending on physical, emotional, social, and environmental changes and events occurring before, during, and after the pregnancy (Sable, et al., 1997). Unintended pregnancies are generally classified as mistimed or unwanted (Shah,et al., 2011). Mistimed pregnancies, or those pregnancies desired at another time, are shown to be associated with low birth weight status (Shah, et al., 2011). Unwanted pregnancies, or those pregnancies not desired at any time, are shown to be associated with low birth weight status and preterm

delivery (Shah, et al., 2011). The results of this study coincide with these findings. When compared to intended pregnancy, mistimed pregnancies (among participants wanting to become pregnant sooner) and unwanted pregnancies were associated with increased adverse pregnant outcomes.

A history of adverse pregnancy outcomes may influence subsequent pregnancy outcomes. Recurrences of adverse pregnancy outcomes in subsequent deliveries may be linked with maternal diabetes (Kovilam, et al., 2002; Sibai, et al., 2000), bacterial vaginosis (Jacobsson, et al., 2002), periodontitis (Madianos, et al., 2001; Offenbacher, et al., 2001); preconception body mass index (Cnattingius, et al., 1998; Sebire, et al., 2001); anemia during pregnancy (Xiong, et al., 2000; Scanlon, et al., 2000); chronic stress and depression (Orr, James, & Blackmore-Prince, 2002; Wadha, et al., 2001), and short interpregnancy intervals (Conde-Agudelo, Rosas-Bermudez, & Kafury-Goeta, 2006; Klerman, Cliver, & Goldenberg, 1998). Health, social, and behavioral factors persisting after a first pregnancy may affect subsequent pregnancies, especially given short interpregnancy periods (Dunlop, et al., 2008). The results of this study coincide with these findings. In all possible iterations of this study, when compared to a prior history of normal pregnancy (no low birth weight or preterm delivery), having no history and a having a prior history of low birth weight status and/or preterm delivery were associated with increased adverse pregnancy outcomes.

Preconception health behaviors. Prepregnancy weight may impact adverse pregnancy outcomes. Obesity prior to pregnancy has been linked to perinatal mortality (Cnattingius, et al., 1998; Kristensen, et al., 2005) and maternal complications (Choi, Park, & Shin, 2011; Doherty, 2006; Leeners, 2006; Ehrenberg, Mercer, & Catalano, 2004; Rode, Nilas, Wojdemann, & Tabor, 2005, Rudra, et al., 2007; Sebire, et al., 2001b). The results of this study corroborate these findings. Overweight status prior to pregnancy was associated with increased adverse pregnancy outcomes in the majority

of the iterations in this study.

Underweight prepregancy status has also been linked to preterm delivery, intrauterine growth restriction, and low birth weight status (Ehrenberg, Dierker, Milluzzi, & Mercer, 2003). In contrast, Cnattingius and colleagues concluded that underweight BMI status prior to pregnancy was associated with decreased risk of preeclampsia, small-for-gestational age infants, and infant mortality (1998). The results of this study support those of Cnattingius and colleagues. For women in the underweight BMI category prior to pregnancy, higher BMI was associated with increased adverse pregnancy outcomes. In this study, the reliance on self-reported responses and the small underweight sample (5%, as opposed to almost 50% in the overweight category) limit generalizability to another population.

The findings for folic acid use in this study were counterintuitive. An increase in the use of folic acid supplementation was associated with increased adverse pregnancy outcomes. There are several possible explanations for this anomaly. First, measurement error may account for the counterintuitive results. The PRAMS survey item addressed the number of times per week a multivitamin was taken. This item assumes that all multivitamins contain the recommended 400 micrograms of folic acid. Without supplementation regulation by the Federal Drug Administration, this assumption cannot be met. Second, maternal age may impact the use of folic acid supplementation. Women between 18 and 24 years of age exhibited the least amount of knowledge regarding the importance of supplementation, and they had the lowest reported daily use of supplementation when compared with older women of reproductive age (Centers for Disease Control and Prevention, 2007g; Evans & Weisman, 2010). In this study, whereas 22.9% of women 24 years and younger, 25.5% of women 25-34 years of age, and 5.4% of women over 34 years of age did not take a multivitamin prior to pregnancy, 5.2%, 19.5%, and 6.6% took a multivitamin every day, respectively. These results

support the finding that younger women report the lowest daily use of supplementation when compared with older women of reproductive age. Older maternal age, as discussed previously, is associated with increased adverse pregnancy outcomes. Thus, the association between increased folic acid use and increased adverse pregnancy outcomes may be impacted by maternal health or pregnancy conditions associated with advancing maternal age. Third, the women taking folic acid supplements may have other risk factors, only one of which is vitamin deficiency. Therefore, their risk would be higher due to the presence of other co-risk factors. Fourth, observational studies demonstrate the effectiveness of folic acid in reducing low birth weight, preterm birth, pre-eclampsia, abruption placentae (Chiaffarino, et al., 2010). However, among 12 controlled clinical trials with folate supplementation versus placebo, supplementation demonstrated no statistically significant effects (Chiaffarino, et al., 2010).

Preconception use of tobacco may impact adverse pregnancy outcomes. The literature links preconception tobacco use with conception delay and infertility (Rosenthal, Melvin, & Barker, 2006). Maternal complications and fetal health risks are typically associated with tobacco use during pregnancy (CDC, 2007; DHHS, 2001). This study demonstrated that cigarette use prior to pregnancy was associated with increased adverse pregnancy outcomes in four out of five iterations.

The results regarding alcohol use prior to pregnancy were counterintuitive in this study. Research demonstrates an increased risk of birth defects, alcohol-related disorders, and fetal brain damage associated with fetal alcohol exposure (CDC, 2006d; Claren, 1986; Jones & Smith, 1973; Moore, Khoury, & Liu, 1997; Mattson & Riley, 1996; Mengel, Searight, & Cook, 2006; Riley, McGee, & Sowell, 2004; Sokol, Delaney-Black, & Nordstrom, 2003; Stratton, Howe, & Battaglia, 1996; Streissguth, 1994; Windham, et al., 1997). However, in the reduced and full framework analyses of Project 2, increased frequency of drinking alcohol and increased prevalence of binge drinking were

associated with decreased adverse pregnancy outcomes. These findings seem counterintuitive, but there are a few possible explanations for such unexpected results. One possibility is measurement error. It is possible that there was a coding error in the PRAMS dataset provided by the Centers for Disease Control and Prevention. Or, it is possible that recall bias impacted the study results. The PRAMS survey ascertained the number of drinks consumed per week (frequency of alcohol use) and the number of occasions on which more than five drinks were consumed (binge drinking) within the three months prior to conception. As the survey was administered several months after delivery, there is over a one-year window of recall for the women responding to these preconception items. In that time frame, a woman's response may vary. Second, the majority of pregnant women tend to reduce their preconception risk behaviors following pregnancy recognition (Anderson, et al., 2006; Tough, Tofflemire, Clarke, & Newburn-Cook, 2006). After pregnancy recognition, participants with higher preconception alcohol consumption may have felt guilty about the possible infliction of harm on their fetus. At that point, these women may have adopted healthier behaviors and increased medical care during the pregnancy to compensate for any possible damage. However, this theory is less feasible when applied to the binge drinking sample. According to Naimi and colleagues (2003b), women who participated in preconception binge drinking were more likely to consume alcohol, binge drink, and smoke during pregnancy. After considering these possible explanations, the association between preconception alcohol use (frequency of use and binge drinking) and decreased adverse pregnancy outcomes is most likely due to measurement error.

The impact of preconception counseling on adverse pregnancy outcomes is also counterintuitive in this study. Preconception counseling has been shown to increase women's knowledge, to increase folic acid use prior to pregnancy, and to reduce alcohol use in early pregnancy (Elsinga, et al., 2008). Studies also demonstrate the association

between preconception counseling and reducing adverse pregnancy outcomes (Dudenhausen, Friese, & Kirschner, 2007; Elsinga, et al., 2008). This study contradicts these findings. In future iterations of the preconception framework, it is possible that folic acid use and contraceptive use may mediate the association between preconception counseling and adverse pregnancy outcomes. Measurement error may be responsible for the counterintuitive association between preconception counseling and increased adverse pregnancy outcomes in this study. Unfortunately, the impact of the preconception counseling item could not be confirmed in Project 2 due its exclusion from the core PRAMS survey.

Prenatal factors. Maternal complications, such as gestational diabetes, incompetent cervix, hypertension, and premature rupture of the membranes, are commonly associated with adverse pregnancy outcomes in the literature (B□nhidy, Acds, Puh□, & Czeizel, 2007; Blickstein, et al., 1989; Casey, et al., 1997; Czeizel & B□nhidy, 2010; Dang, Homko, & Reece, 2000; Ganzevoort, et al., 2007; Jauniaux, Van Oppenraaij, & Burton, 2010; Kjos & Buchanan, 1999; Mitanchez, 2010; Nelson, et al., 2009; Pettitt, et al., 1980; Schneider, et al., 2010; Setji, Brown, & Feinglos, 2005; Treadwell, et al., 1991; Walsh, et al., 2010; Yang, et al., 2004; Yeast & Garite, 1988; Zetterstr□m, et al., 2005). This study confirmed these findings. Maternal complications and hospitalization during pregnancy were associated with increased adverse pregnancy outcomes. Maternal complications are also associated with smoking, maternal age, inadequate gestational weight gain, and underweight prepregnancy body mass index (Choi, Park, & Shin, 2011; Hayashi, et al., 2011; Ziadeh, 2002). In future iterations of the preconception framework, maternal complications may be integrated as a mediator between such factors and adverse pregnancy outcomes.

Through the treatment of maternal medical conditions, reducing potential risk factors, and addressing behavioral factors, prenatal care attempts to reduce adverse

pregnancy outcomes (U.S. Department of Health and Human Services, 2000). Early and continuous prenatal care is recommended by the American Academy of Pediatrics [AAP] and the American College of Obstetricians and Gynecologists [ACOG] (AAP & ACOG, 1992). This study supports these recommendations. Later prenatal care initiation and fewer prenatal care visits were associated with increased adverse pregnancy outcomes. However, in this study, the Kessner Index indicated an association between adequate prenatal care and increased adverse pregnancy outcomes. This variable was added in the post hoc analysis, and this finding is counterintuitive. The Kessner Index adjusts the timing and quantity of prenatal care for the length of gestation to obtain the adequacy of prenatal care (Kessner, Singer, Kalk, & Schlesinger, 1973). Measurement error may account for this discrepancy. When applying four indices of prenatal care utilization (GINDEX, Kessner Index, Adequacy of Prenatal Care Utilization [APNCU], and the revised GINDEX [R-GINDEX]) to models for preterm delivery and infant mortality, results varied (VanderWeele, Lantos, Siddique, & Lauderdale, 2009). One index (the GINDEX) even provided counterintuitive results similar to those found in this study (VanderWeele, Lantos, Siddique, & Lauderdale). However, most researchers no longer use the Kessner Index or the GINDEX due to the restricted nine-visit coding limitation which inaccurately classifies prenatal care utilization of term and post-term pregnancies (Alexander & Kotelchuck, 2001; Alexander & Kotelchuck, 1996; Heaman, et al., 2008).

Gestational weight gain was included in the post hoc analysis. The Institutes of Medicine (IOM) provides general guidelines for gestational weight gain based upon prepregnancy body mass index [BMI] (2009). Recommendations indicate that women with lower BMI scores should gain more weight during pregnancy (e.g., underweight women should gain 28-40 pounds) and women with higher BMI scores should gain less weight during pregnancy (e.g., obese women should gain 11-20 pounds) (IOM).

According to a study conducted by Crane and colleagues, only 30.6% of women gained the recommended amount of weight during pregnancy; 52.3% of women gained more than recommended, and 17.1% gained less than recommended (2009). Among women of normal weight, overweight, or obese status, adverse pregnancy outcomes were decreased among women with recommended weight gain than in those with excessive weight gain (Crane, 2009). In opposition, the finding of the present study indicated an association between increased gestational weight gain and decreased adverse pregnancy outcomes. The PRAMS data regarding gestational weight gain is derived from birth certificate data. However, birth certificate data relies on self-report of gestational weight gain (Wright, et al., 2010). Wright and colleagues examined self-report birth certificate data regarding gestational weight gain compared with electronic medical records to ascertain accuracy (2010). Among women within the normal BMI range, those with excessive gestational weight gain were more likely to under-report their gain compared to women with adequate gestational weight gain (RR 6.0; 95% CI: 3.0-12.1) (Wright, et al., 2010). These findings may partially explain the unexpected results in the present study. Systematic bias may limit the use of birth certificate data regarding gestational weight gain (Wright, et al.).

Natal factors. The natal factors included in this discussion were part of the post hoc analysis. Three variables demonstrated significant associations: plurality, first cesarean-section, and repeated cesarean-section. Between 1971 and 1997, twin births increased 53%, 32%, 31%, and 83% among White, African-American, Native American, and Mexican-American women, respectively (Keith, Oleszczuk, & Keith, 2000). In the same time period, triplet, quadruplet, and quintuplet births increased four-fold, eleven-fold, and five-fold, respectively (Keith, Oleszczuk, & Keith). In vitro fertilization, which is associated with increased risk of adverse pregnancy outcomes, often results in plurality (Jackson, Gibson, Wu, & Croughan, 2004; Shevell, et al., 2005). Multiple gestation is

associated with increased risk of preterm delivery (1.7% for singletons vs. 41.2% for triplets), low birth weight (1.1% for singletons vs. 31.9% for triplets), and infant mortality (11.2 for singletons vs. 190.4 for triplets) (Keith, Oleszczuk, & Keith; Mathews & MacDorman, 2007; National Center for Health Statistics, 2008; Onyiriuka, 2010). Thus, this study supports the findings that plurality is associated with an increase in adverse pregnancy outcomes.

Delivery by cesarean section was also associated with increased adverse pregnancy outcomes in this study. In part, this may be due to the cutoff point chosen for length of maternal hospital stay. Cesarean section delivery is associated with a longer hospital stay due to its surgical nature, and the four-day cutoff period chosen in this study may have been exceeded by mothers who underwent a cesarean section. Cesarean sections are also performed in cases associated with maternal complications or high-risk pregnancy, increasing the chance of an association between c-section and adverse pregnancy outcomes (March of Dimes, 2008c). In addition, older maternal age is associated with cesarean section in the literature. Deliveries by cesarean section occurred in 71.2%, 78.5%, and 85.9% of twin gestation cases among women 20-34 years of age, 35-39 years of age, and 40 years and older, respectively (Kathiresan, et al., 2010). Higher rates of cesarean section and older maternal age are associated with induced labor, especially elective induction (Ecker, et al., 2001). It is possible that cesarean section acts as a mediating factor between maternal age and adverse pregnancy outcomes. Cesarean sections are also associated with body mass index (BMI) in the literature. Cesarean section rates increased from 18.2% among women with normal BMI scores to 40.6% among women with obese BMI scores (RR 2.2; 95% CI: 1.7-2.8) (Mantakas & Farrell, 2010). It is possible that cesarean section acts as a mediating factor between prepregnancy maternal weight status and adverse pregnancy outcomes.

The estimates obtained for these variables were small in magnitude, and therefore regardless of the direction of the estimate, these results must be interpreted with caution. The highest R-squared value obtained corresponds to the post hoc analysis with an R-squared value of 0.305. This figure indicates that, at most, the preconception framework with supplemental variables explains only 30.5% of the variance associated with adverse pregnancy outcomes as specified in this study.

Strengths and Limitations

Strengths. This study contributes to the literature in several ways. First, this study uniquely assessed the impact of preconception health behaviors on adverse pregnancy outcomes in relation to environmental factors, personal influences, and prenatal factors. This study demonstrated that preconception health behaviors alone had a negligible impact on adverse pregnancy outcomes. When combined with other factors, the preconception framework explained less than one-third of the variance in adverse pregnancy outcomes, and further research is necessary to address the unexplained variance.

Second, this was the first study to examine PRAMS data in relation to preconception health behaviors using structural equation modeling. This type of analysis was made possible through the use of Mplus statistical software which allowed for an analysis of the complex analysis weights and the numerous categorical variables associated with the PRAMS dataset. Use of structural equation modeling allowed for an examination of the framework as a whole while controlling for Type I, or experimentwise, error (Wothke, 2000; Arbuckle, 1996).

Third, this study resulted in some unexpected associations. These associations may be products of measurement error, but they may have some theoretical grounding. Further analyses are necessary to confirm or deny such unexpected findings.

Finally, this was the starting point toward the development of the preconception

framework. Several modifications require investigation, but the framework in its entirety may prove useful in the future study of preconception health.

Limitations. The scope of any study is restricted by its limitations. In this study, there are several limitations to consider. First, this study relied on self-reported cross-sectional data. Self-reported data may be subject to potential sources of error including response bias which is a concern in any pregnancy-related study. Participants may be influenced to respond in the way they think the researcher or society wants them to respond. For example, a mother that consumes alcohol during her pregnancy may deem the behavior socially undesirable. She might then respond untruthfully to a survey about her alcohol use during pregnancy. Several preconception health behaviors may fall into this social desirability bias trap, such as the use of folic acid to prevent birth defects and the harmful effects of cigarettes and alcohol prior to pregnancy. This type of bias may influence the results of this study. In addition, cross-sectional data is collected at one point in time, thus rendering the inference of cause and effect impossible.

Second, the PRAMS data used in this study relied heavily on recall bias. Recall bias poses a problem when dealing with retrospective preconception health behaviors studies and the PRAMS dataset is no exception. Whether participants responded to the PRAMS survey within one week or several months following delivery, there is automatically at least a nine-month pregnancy window in addition to the three-month preconception period. Therefore, preconception survey questions are posed at least one year after the behaviors in question. For example, an item concerning the number of alcoholic beverages consumed per week in the three months prior to becoming pregnant is subject to recall bias. Thus, this type of bias may influence the results of this study. Variables allowing the linkage of the date of survey completion to the date of birth were not available to the public due to privacy limitations associated with the PRAMS dataset. Therefore, recall bias was not assessed in this study.

Third, this study may be affected by nonresponse bias. The PRAMS complex sampling weights initially accounted for nonresponse bias according to those participants failing to complete the survey. However, a list-wise deletion of the missing data in Projects 1 and 2 resulted in a large portion of participant exclusion. According to descriptive statistical analyses, the demographic profile of missing participants significantly differed from the demographic profile of study participants. In both projects, those participants excluded from the study were more extreme in maternal age (younger and older), more racially diverse (more identified as black, Asian, and other racial categories), more identified as Hispanic, uninsured, receiving Medicaid, with lower income levels, and with less education. Due to less education and possibly due to racial or ethnic barriers, the PRAMS dataset may have posed issues of readability that contributed to the amount of missing data from this population. The PRAMS dataset may benefit from a reduction in the level of readability. Following list-wise deletion, this study demonstrated response bias due to the differences in early responders and late responders. According to the results of the sub-analysis comparing mail and telephone responders, there were demographic differences between the two groups. Late responders, or those participants responding by telephone, were younger, more racially diverse (more identified as black and other nonwhite racial categories), more identified as Hispanic, uninsured, receiving Medicaid, with lower income levels, and with less education. Again, readability of the survey may have posed problems for the telephone participants due to lower levels of literacy.

Fourth, the preconception framework may require modification to more accurately reflect the interactive nature among the variables included. The conceptualization of the preconception framework began based upon the literature related to preconception health. Over time, it encompassed environmental and personal factors, and later prenatal and postnatal factors. All of these factors are thought to

influence the prevalence of adverse pregnancy outcomes, but their interactions within the comprehensive framework are less known. Therefore, this study assessed the influence of all factors on adverse pregnancy outcomes. However, there may be other variable configurations that improve the fit of the framework. For example, this study demonstrated the statistical significance of maternal complications on adverse pregnancy outcomes. Some of these complications, like placenta previa, may be caused by random occurrence or by genetics. However, other complications, like preeclampsia, may be more heavily influenced by preconception behaviors. Therefore, certain maternal complications may in fact be mediating factors between preconception health behaviors and adverse pregnancy outcomes. The interactions between the variables in the preconception framework would need to be reevaluated based upon theory and research results prior to framework reconfiguration.

Fifth, there may be unmeasured variables or unknown factors not presently included in the framework. This study was limited to the variables included in the PRAMS dataset. However, there are other preconception behaviors that may influence adverse pregnancy outcomes, such as mercury exposure from frequent fish consumption. The PRAMS dataset limits preconception health behaviors to a possible six variables, but there may be other behaviors or different types of factors that influence the results of this study. In addition, unknown variables may have been omitted from the PRAMS dataset and subsequently from this study. According to nature versus nurture, some variables can be measured, such as those in the preconception framework, and some cannot, such as genetic predisposition. Thus, there are possible unknown factors that may not be measured in relation to the preconception framework that influence adverse pregnancy outcomes.

Finally, the use of secondary data presents several limitations related to this study. As with any study, there is the possibility of measurement error. Measurement

error increases the chance of making a Type II error, or failing to detect an existing relationship. Item construction and psychometric testing play a significant role in response rate and accurate completion of survey data. For example, the construction of the contraception item excluded from this analysis may have accounted for its low response rate. The length of the survey may have been prohibitive as well. The PRAMS survey length varies from about 60-90 questions depending upon optional standard state and state-specific question inclusion (D'Angelo, D.V., November 13, 2009). Longer surveys may have influenced survey completion and missing data frequency for certain states. Even with pilot testing, it is apparent that the PRAMS dataset does not account for the relationship between infant mortality and postnatal variables. In addition, the use of multi-state data requires strenuous data cleaning and accurate coding verification, and any possible errors may influence the results of the study. Also, validity for the PRAMS questionnaire has only been assessed via two studies limited to the smoking and assisted reproductive technology items (D'Angelo, D.V., November 13, 2009). The present study is limited to the items and scaling inherent in the PRAMS questionnaire, with noted exclusion of such items as emotional violence, sexual violence, maternal narcotic/amphetamine/marijuana use, genetic testing, maternal sexually transmitted infections, and postnatal insurance status. The study is also limited to the core items of the PRAMS data and to the standard state items used by only certain states. This study is limited to an examination of PRAMS state data available for public use. For example, the PRAMS data from Vermont is small enough to require restricted use based upon privacy issues. Therefore, this study is limited to only those states that participated in PRAMS between 2005 and 2008 with complete data and no privacy exclusions. The exclusion criteria also present certain limitations when working with the PRAMS dataset. All out-of-state births to residents and all in-state births to nonresidents were excluded from the PRAMS dataset. Therefore, mothers who

have immigrated legally without permanent residency or immigrated illegally to the United States were excluded from the study. The immigrant population in the United States increased from about 4% in 1970 to about 12.5% in 2007 (Camarota, 2007; Singh & Yu, 1996), and nearly one in three immigrants is an illegal alien (Camarota, 2007). The immigrant population tends to be less educated, poorer, and lacking health insurance compared to the native population (Camarota, 2007). Therefore, immigration status may impact adverse pregnancy outcomes, and its exclusion is a limitation of the PRAMS dataset. Also, the PRAMS dataset includes only pregnancies resulting in a live-born infant, thus excluding stillbirths or late fetal deaths. Stillbirths are shown to be associated with adverse pregnancy outcomes (Astolfi, De Pasquale, & Zonta, 2005; Rasmussen, Irgens, Skjaerven, & Melve, 2009; Subramoney, d'Espaignet, & Gupta, 2010). Thus, the exclusion of stillbirths is a limitation of the PRAMS dataset.

Implications for Future Research

This study is a building block in the study of preconception health behaviors in a broad context. Further research is required to establish the reliability of the results of this study and to examine possible variations of the preconception framework.

First, the PRAMS questionnaire may benefit from modification. The two preconception health behavior items related to obtaining oral health care and obtaining medical health care should be included in the core portion of the PRAMS questionnaire administered to all states. Additional preconception health variables might warrant consideration, such as weekly fish consumption to ascertain the impact of mercury on a developing fetus. An effort to obtain postnatal information from women who experienced infant mortality should be made. Further efforts to obtain any missing information should also be attempted.

Second, the preconception framework requires modification. The configuration of the existing variables may be modified to further identify possible mediating variables,

such as certain maternal complications. Additional variables impacting adverse pregnancy outcomes may be added to increase the amount of explained variance associated with adverse pregnancy outcomes in the preconception framework. A few of the studies that have demonstrated associations with adverse pregnancy outcomes include vitamin D (Bodnar & Simhan, 2010; Scholl & Chen, 2009); sleep (Naud, et al., 2010); rurality (Bailey & Cole, 2009); maternal employment (Bell, Zimmerman, & Diehr, 2008); racial density (Pickett, et al., 2005); and particulate air pollution (Yi, Kim, & Ha, 2010).

Third, the preconception framework may be applied to other research datasets. It is possible that other datasets also incorporate items related to preconception health behaviors, as well as the items related to surrounding contextual factors. Application of the preconception framework to another dataset may substantiate the results found with the PRAMS dataset or it may render different results entirely. Datasets that include some preconception health variables include the Behavioral Risk Factor Surveillance System and the Central Pennsylvania Women's Health Study.

Ideally, any preconception health behavior study would be prospective in nature, because retrospective recall is difficult for many participants and may introduce bias. A prospective study would ensure the accuracy of preconception health behavior data, but it is often considered too time-consuming and cost-prohibitive for most research projects. To reduce the costs associated with a purely prospective study, it would be possible to initiate a study that collects preconception data from women in the first trimester of pregnancy and follows them to term.

Considering the limitations associated with this study, the limitations associated with the PRAMS dataset, and the resulting poor predictive value of preconception health behaviors, the validity of recommendations regarding preconception health behaviors and the cost of accumulating vast amounts of data must be scrutinized. If the PRAMS

survey is flawed by the exclusion of high-risk populations for adverse pregnancy outcomes and an innate potential for recall bias, then the impact of preconception health behaviors may be greater than the results presented in this study. If so, the PRAMS survey could be split into two sections: 1) the current PRAMS survey without preconception health behaviors and 2) a separate preconception health behaviors survey administered in the first trimester of pregnancy. The PRAMS survey, in either case, would benefit from improved psychometric evaluation and reducing the readability level to decrease the amount of missing data. However, if the PRAMS survey accurately ascertains preconception health behaviors, then the impact of preconception health behaviors is negligible per the results of this study. If so, emphasizing preconception health behaviors in the public health arena will be ineffectual in remedying adverse pregnancy outcomes and other solutions must be examined.

Implications for Public Health Practice

Because nearly half of all pregnancies are unintended, yielding about three million unintended pregnancies in the U.S. annually (DHHS, 2000), there is a need to shift care to an earlier period in a woman's life cycle with greater potential to prevent birth defects and other adverse pregnancy outcomes, also known as preconception care (Bennett & Kotelchuck, 2005). The goal of preconception care is to provide health promotion, screening, and interventions for the more than 62 million women of childbearing age in the United States (Johnson, 2006; U.S. Census Bureau, 2005).

According to this study, the relationship between preconception health behaviors and adverse pregnancy outcomes is unclear. Preconception health behaviors alone account for a negligible portion of the variance associated with adverse pregnancy outcomes. In combination with other contextual factors, like environmental factors, personal influences, prenatal factors, and natal factors, the framework accounts for almost a third of the total variance in adverse pregnancy outcomes. The majority of

significant factors in this study were not related to behavior change, and therefore, present as predisposing factors for adverse pregnancy outcomes: pregnancy history, maternal age, maternal race, Hispanic ethnicity, maternal complications, hospitalization during pregnancy, plurality, and cesarean section. However, several of these factors may be influenced by behavior, such as the impact of exercise and diet on maternal complications like preconception diabetes and hypertension.

Further studies are necessary to provide preconception health guidelines for health care providers and the general public. The results of this study must be interpreted with caution, and the findings from this study have limited generalizability to the general population. Until the findings of this study are corroborated or otherwise substantiated through additional analysis, however, it is still conscionable that health care providers, insurance companies, and health educators promote basic health guidelines to all women of reproductive age at any and all possible health encounters. Basic health guidelines include maintenance of a healthy BMI score (not underweight or overweight), consumption of appropriate levels of folate (preferably through whole foods high in folate), avoidance of tobacco products, and limitations of alcohol intake. These health guidelines may be employed by all persons, regardless of age and gender. However, the adherence to these guidelines among women of reproductive age may improve adverse pregnancy outcomes in the event that a planned or unplanned pregnancy may occur.

Dissemination of Findings

The findings of this study in relation to preconception health behaviors are indeterminate. Nevertheless, dissemination of the findings is still important to encourage other researchers to determine what has been done and what can be done in the future. Therefore, the results from this study will be submitted for publication, targeting such journals as the *American Journal of Public Health,* the *Maternal and Child Health*

Journal, and the *American Journal of Obstetricians and Gynecologists*. The results also will be submitted for the MCH Section of the APHA convention and for the National Summit on Preconception Health and Health Care. Research results also will be shared with the Centers for Disease Control and Prevention, as well as the PRAMS-participating states in Project 1, in exchange for the use of the PRAMS dataset.

Summary of the Conclusions

This study examined the impact of preconception health behaviors on adverse pregnancy outcomes through the theoretical lens of reciprocal determinism. Preconception health behaviors alone accounted for a negligible portion of the variance associated with adverse pregnancy outcomes. As hypothesized, preconception health behaviors work in concert with environmental factors, personal influences, prenatal and natal factors. Significant predictors supported in the literature included lower socioeconomic status, pregnancy intention, pregnancy history, older maternal age, black maternal race, Hispanic ethnicity, overweight maternal BMI, tobacco use prior to pregnancy, maternal complications, hospitalization during pregnancy, later prenatal care initiation, fewer prenatal care visits, plurality, and cesarean section. Even so, there is a large portion of the variance in adverse pregnancy outcomes that is not accounted for, and further examination is required.

Chapter 6: List of References

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Appendices

Appendix A: Frequency Distributions for All Variables for Each Sample

Variable (Variable Name)	Survey Items and Response Options	Project 1			Project 2		
		Freq.	Wtd. Freq.	%	Freq.	Wtd. Freq.	%
Insurance status (INSURE)	Just before you got pregnant, did you have health insurance?						
	A. No	3,794	148,595	30.0	47,824	1,987,455	34.5
	B. Yes	8,445	346,660	70.0	80,727	3,777,541	65.5
Medicaid status (MEDICAD3)	Just before you got pregnant, were you on Medicaid?						
	A. No	10,527	433,880	87.6	109,922	5,010,170	86.9
	B. Yes	1,712	61,375	12.4	18,629	754,826	13.1
Income level (INCOME5)	During the 12 months before your new baby was born, what was your total household income before taxes?						
	A. Less than $10,000	1,757	70,215	14.2	25,437	988,505	17.1
	B. $10,000 to $14,999	1,028	41,392	8.4	11,944	491,887	8.5
	C. $15,000 to $19,999	750	27,948	5.6	8,439	364,991	6.3
	D. $20,000 to $24,999	923	36,853	7.4	9,533	415,866	7.2
	E. $25,000 to $34,999	1,567	63,187	12.8	13,455	595,318	10.3
	F. $35,000 to $49,999	1,825	70,379	14.2	14,417	634,854	11.0
	G. $50,000 or more	4,389	185,282	37.4	45,326	2,273,575	39.4
Education level (MAT_ED)	From birth certificate data						
	A. 0-8 years	134	5,953	1.2	2,749	135,998	2.4
	B. 9-11 years	1,203	40,474	8.2	14,661	604,889	10.5
	C. 12 years	3,824	147,605	29.8	38,412	1,625,109	28.2
	D. 13-15 years	3,237	142,688	28.8	32,727	1,460,212	25.3
	E. 16 years or more	3,841	158,535	32.0	40,002	1,938,786	33.6

External stress (STRS_TT3)	CDC Computed – total number of stresses						
	A. 0	3,262	131,551	26.6	35,235	1,658,437	28.8
	B. 1	3,142	125,122	25.3	30,801	1,417,764	25.0
	C. 2	2,157	84,861	17.1	22,382	999,639	17.3
	D. 3	1,487	61,236	12.4	15,219	672,249	11.7
	E. 4	878	38,932	7.9	9,640	394,939	6.9
	F. 5	536	22,290	4.5	6,326	270,706	4.7
	G. 6	317	12,963	2.6	3,953	161,777	2.8
	H. 7	216	8,901	1.8	2,438	95,313	1.7
	I. 8	145	5,971	1.2	1,357	51,838	0.9
	J. 9	56	1,829	0.4	666	22,895	0.4
	K. 10	22	690	0.1	329	11,914	0.2
	L. 11	11	505	0.1	138	4,699	0.1
	M. 12	7	184	0.0	50	1,927	0.0
	N. 13	3	220	0.0	17	896	0.0
Physical abuse (PABF5_NO)	CDC Computed – no physical abuse during the 12 months before pregnancy						
	A. No	551	21,972	4.4	7,555	293,300	5.1
	B. Yes	11,688	473,283	95.6	120,996	5,471,695	94.9
Pregnancy intention (FEEL_PG)	Thinking back to just before you got pregnant with your new baby, how did you feel about becoming pregnant?						
	A. I wanted to be pregnant sooner	2,479	93,025	18.8	23,747	1,021,740	17.7
	B. I wanted to be pregnant later	3,365	144,444	29.2	39,507	1,753,428	30.4
	C. I wanted to be pregnant then	5,384	210,262	42.5	52,191	2,439,778	42.3
	D. I didn’t want to be pregnant then or any time in the future	1,011	47,523	9.6	13,106	550,048	9.5

(PREG_TRY)	When you got pregnant with your new baby, were you trying to get pregnant?						
	A. No	5,352	231,473	46.7	65,136	2,845,748	49.4
	B. Yes	6,887	263,782	53.3	63,415	2,919,247	50.6
Maternal age Dataset 1: (MAT_AGE) Dataset 2: (MAT_AGE_NAPHSIS)	From birth certificate data						
	A. 17 years of age or younger	243	7,480	1.5	3,153	114,074	2.0
	B. 18-19 years of age	638	28,476	5.7	8,392	330,978	5.7
	C. 20-24 years of age	3,012	129,969	26.2	31,759	1,358,219	23.6
	D. 25-29 years of age	3,938	163,577	33.0	36,380	1,701,642	29.5
	E. 30-34 years of age	2,713	109,619	22.1	29,058	1,414,774	24.5
	F. 35-39 years of age	1,177	46,757	9.4	16,240	696,919	12.1
	G. 40 years of age or older	218	9,375	1.9	3,569	148,390	2.6
Race/Ethnicity	From birth certificate data						
(HISP_BC)	Hispanic						
	A. Yes	640	20,831	4.2	13,909	657,016	11.4
	B. No	11,599	474,424	95.8	114,642	5,107,979	88.6
(MAT_RACE)	Race/Ethnicity						
	A. Other Asian	142	5,895	1.2	5,038	149,348	2.6
	B. White	11,103	439,185	88.7	86,917	4,380,459	76.0
	C. Black	779	35,931	7.3	21,615	884,073	15.3
	D. American Indian	78	2,288	0.5	3,611	55,038	1.0
	E. Chinese	17	1,581	0.3	1,682	41,826	0.7
	F. Japanese	14	601	0.1	988	14,176	0.2
	G. Filipino	7	148	0.0	1,960	38,683	0.7
	H. Hawaiian	10	376	0.1	1,296	17,703	0.3
	I. Other Nonwhite	58	6,240	1.3	2,612	129,341	2.2
	J. Alaskan Native	0	0	0.0	1,400	7,218	0.1
	K. Mixed Race	31	3,011	0.6	1,432	47,130	0.8

Previous pregnancy outcomes (PREGHX)	CDC computed – history of previous live births						
	A. No previous live birth	5,262	193,172	39.0	57,907	2,493,470	43.3
	B. OK (not low birth weight or preterm)	5,714	258,894	52.3	55,832	2,757,066	47.8
	C. Low birth weight	276	9,544	1.9	3,771	139,498	2.4
	D. Preterm	448	19,341	3.9	5,016	203,128	3.5
	E. Low birth weight and preterm	539	14,305	2.9	6,025	171,833	3.0
Weight Management (MOM_BMI)	CDC calculated – Body Mass Index (based on height and weight prior to pregnancy)						
	A. Underweight - BMI under 18.5	658	24,074	4.9	6,856	264,376	4.6
	B. Normal weight – BMI 18.5 to 24.9	6,131	246,364	49.7	61,174	2,795,807	48.5
	C. Overweight – BMI 25.0 to 29.9	2,993	124,450	25.1	32,604	1,489,123	25.8
	D. Obese (includes all classes) – BMI 30.0 or greater	2,457	100,367	20.3	27,917	1,215,689	21.1
Folic acid use (VITAMIN)	During the month before you got pregnant with your new baby, how many times a week did you take a multivitamin or a prenatal vitamin?						
	A. I didn't take a multivitamin or a prenatal vitamin at all.	6,096	256,037	51.7	70,278	3,101,347	53.8
	B. 1 to 3 times a week	1,178	45,961	9.3	11,210	499,130	8.7
	C. 4 to 6 times a week	1,024	42,522	8.6	7,924	378,737	6.6
	D. Every day of the week	3,941	150,735	30.4	39,139	1,785,782	31.0
Preconception avoidance of tobacco (SMK5_3B)	In the 3 months before you got pregnant, how many cigarettes did you smoke on an average day?						
	A. 41 cigarettes or more	112	3,922	0.8	1,410	51,653	0.9
	B. 21 to 40 cigarettes	290	12,637	2.6	2,758	104,801	1.8
	C. 11 to 20 cigarettes	1,062	45,095	9.1	11,111	461,822	8.0
	D. 6 to 10 cigarettes	698	30,030	6.1	9,273	378,232	6.6
	E. 1 to 5 cigarettes	503	20,090	4.1	7,369	307,792	5.3
	F. Less than 1 cigarette	94	3,320	0.7	1,159	54,346	0.9
	G. None (0 cigarettes)	9,480	380,160	76.8	95,471	4,406,349	76.4

Preconception avoidance of alcohol (DRK5_3B)	During the 3 months before you got pregnant, how many alcoholic drinks did you have in an average week?						
	A. 14 drinks or more a week	136	5,212	1.0	1,553	61,438	1.1
	B. 7 to 13 drinks a week	283	10,562	2.1	3,065	145,670	2.5
	C. 4 to 6 drinks a week	612	26,352	5.3	7,428	361,098	6.3
	D. 1 to 3 drinks a week	1,511	63,986	12.9	18,857	916,884	15.9
	E. Less than 1 drink a week	3,112	133,939	27.0	36,192	1,706,791	29.6
	F. I didn't drink then	6,585	255,204	51.5	61,456	2,573,114	44.6
(DRK5_3BB)	During the 3 months before you got pregnant, how many times did you drink 5 alcoholic drinks or more in one sitting?						
	A. 6 or more times	246	9,705	2.0	2,800	125,259	2.2
	B. 4 to 5 times	259	10,602	2.1	2,831	132,663	2.3
	C. 2 to 3 times	883	38,859	7.8	10,061	476,993	8.3
	D. 1 time	756	33,767	6.8	8,600	415,797	7.2
	E. I didn't have 5 drinks or more in 1 sitting	3,524	148,456	30.0	42,805	2,040,279	35.4
	F. I didn't drink then	6,571	253,866	51.3	61,454	2,574,004	44.6
Obtaining oral care (DDS_BEFR)	When did you have your teeth cleaned by a dentist or a dental hygienist?						
	a. Before my most recent pregnancy						
	i. No	1,649	67,504	13.6	N/A	N/A	N/A
	ii. Yes	10,590	427,751	86.4	N/A	N/A	N/A
Obtaining medical care (BPG_TALK)	Before you got pregnant with your new baby, did you talk with a doctor, nurse, or other health care worker to prepare for a healthy pregnancy and baby?						
	A. No	8,486	356,638	72.0	N/A	N/A	N/A
	B. Yes	3,753	138,617	28.0	N/A	N/A	N/A

Tobacco use during pregnancy (SMK5_3L)	In the last 3 months of your pregnancy, how many cigarettes did you smoke on an average day?						
	A. 41 cigarettes or more	26	769	0.2	319	11,898	0.2
	B. 21 to 40 cigarettes	36	2,357	0.5	633	23,069	0.4
	C. 11 to 20 cigarettes	293	13,680	2.8	3,096	119,687	2.1
	D. 6 to 10 cigarettes	486	20,841	4.2	5,204	194,127	3.4
	E. 1 to 5 cigarettes	616	22,865	4.6	7,801	290,027	5.0
	F. Less than 1 cigarette	171	7,598	1.5	2,121	87,488	1.5
	G. None (0 cigarettes)	10,611	427,145	86.2	109,377	5,038,699	87.4
Alcohol use during pregnancy (DRK5_3L)	During the last 3 months of your pregnancy, how many alcoholic drinks did you have in an average week?						
	A. 14 drinks or more a week	9	368	0.1	127	5,908	0.1
	B. 7 to 13 drinks a week	12	451	0.1	87	4,180	0.1
	C. 4 to 6 drinks a week	15	762	0.2	262	13,533	0.2
	D. 1 to 3 drinks a week	109	4,070	0.8	1,452	72,814	1.3
	E. Less than 1 drink a week	503	20,413	4.1	6,386	332,152	5.8
	F. I didn't drink then	11,591	469,190	94.7	120,237	5,336,408	92.6
(DRK5_3LB)	During the last 3 months of your pregnancy, how many times did you drink 5 alcoholic drinks or more in one sitting?						
	A. 6 or more times						
	B. 4 to 5 times	13	468	0.1	214	10,150	0.2
	C. 2 to 3 times	5	243	0.0	100	3,617	0.1
	D. 1 time	21	556	0.1	250	10,681	0.2
	E. I didn't have 5 drinks or more in 1 sitting	23	1,774	0.4	377	13,702	0.2
	F. I didn't drink then	584	23,323	4.7	7,402	388,115	6.7
		11,593	468,890	94.7	120,208	5,338,731	92.6
Maternal complications (MATLCOMP)	Occurrence of maternal complications during most recent pregnancy – number of factors Possible complications include: vaginal bleeding; kidney or						

Based on MORB_DID MORB_BLD MORB_KID MORB_NAU MORB_CRV MORB5BP MORB_PLA MORB_LAB MORB_PRM MORB_TRN	bladder (urinary tract) infection; severe nausea, vomiting or dehydration; incompetent cervix; high blood pressure, hypertension; placental problems; labor pains more than 3 wks prior to due date; premature rupture of the membranes; required blood transfusion.						
	A. 0	3,682	178,508	36.0	39,521	2,170,821	37.7
	B. 1	3,470	146,669	29.6	35,974	1,707,903	29.6
	C. 2	2,516	95,382	19.3	26,171	1,066,182	18.5
	D. 3	1,455	46,226	9.3	15,314	518,334	9.0
	E. 4	744	19,386	3.9	7,559	207,203	3.4
	F. 5	257	6,637	1.3	2,898	72,238	1.3
	G. 6	93	1,991	0.4	843	16,430	0.3
	H. 7	15	366	0.1	206	3,788	0.1
	I. 8	6	74	0.0	30	366	0.0
	J. 9	0	0	0.0	13	348	0.0
	K. 10	1	15	0.0	22	1,383	0.0
Prenatal education (PRNTLEDU)	Topics of discussion with a doctor, nurse, or other health care worker during any prenatal care visits – number of topics						
Based on TLK_SMK TLK_DRK TLK_BELT TLK_BC TLK_MEDS TLK_DRUG TLK_BDEF TLK_LABR TLK_HIVT TLK_ABUS	Possible topics include: during pregnancy – smoking, drinking alcohol, seat belt use, taking medications, illegal drug use, genetic or birth defect screenings, procedures if labor starts early, HIV testing, and physical abuse.						
	A. 0	82	3,121	0.6	888	38,139	0.7
	B. 1	189	7,787	1.6	1,686	66,617	1.2
	C. 2	495	20,114	4.1	3,903	161,150	2.8
	D. 3	884	36,856	7.4	6,963	303,494	5.3
	E. 4	1,281	51,396	10.4	10,066	455,257	7.9
	F. 5	1,310	57,065	11.5	11,381	548,173	9.5
	G. 6	1,071	43,024	8.7	10,888	486,862	8.4
	H. 7	1,127	47,459	9.6	12,194	539,473	9.4
	I. 8	1,445	57,882	11.7	15,598	697,525	12.1
	J. 9	1,527	57,582	11.6	17,739	811,254	14.1

	K. 10	2,828	112,970	22.8	37,245	1,657,052	28.7
Initiation of prenatal care (PNC_WKS)	How many weeks or months pregnant were you when you had your first visit for prenatal care (CDC converted all to weeks)?						
	A. Week 4 or earlier	1,072	45,757	9.2	16,825	732,594	12.7
	B. Between weeks 5 and 8	5,096	210,038	42.4	46,582	2,498,087	43.3
	C. Between weeks 9 and 12	4,252	167,400	33.8	35,314	1,555,624	27.0
	D. Between weeks 13 and 16	1,199	45,372	9.2	13,175	567,334	9.8
	E. Between weeks 17 and 20	360	15,642	3.2	5,085	219,258	3.8
	F. Between weeks 21 and 24	141	6,244	1.3	2,512	108,223	1.9
	G. Between weeks 25 and 28	76	3,025	0.6	1,190	51,180	0.9
	H. Between weeks 29 and 32	24	1,004	0.2	476	20,282	0.4
	I. Between weeks 33 and 36	10	255	0.1	157	6,581	0.1
	J. Between weeks 37 and 40	0	0	0.0	43	1,991	0.0
	K. Between weeks 40 and 44	1	175	0.0	13	729	0.0
	L. Between weeks 45 and 48	5	218	0.0	33	1,227	0.0
	M. Week 49 or later	3	123	0.0	46	1,884	0.0

Adverse Pregnancy Outcomes	Occurrence of adverse pregnancy outcomes – number of outcomes experienced Possible adverse pregnancy outcomes include: - Preterm delivery (less than or equal to 259 day/37 weeks) - Low birth weight (less than or equal to 2,500 grams) - Use of the Neonatal Intensive Care Unit (NICU) - Length of infant hospital stay (4 days or more) - Length of maternal hospital stay (4 days or more) - Small for gestational age (computed via algorithm) - Infant mortality						
	A. 0	6,023	327,529	66.1	60,589	3,588,517	62.2
	B. 1	1,854	80,239	16.2	21,698	1,035,844	18.0
	C. 2	1,365	49,999	10.1	15,743	661,688	11.5
	D. 3	850	18,452	3.7	8,338	233,123	4.0
	E. 4	962	9,906	2.0	9,435	122,783	2.1
	F. 5	1,089	8,507	1.7	11,614	112,143	1.9
	G. 6	96	623	0.1	1,111	10,709	0.2
	H. 7	0	0	0.0	23	187	0.0

Appendix B: Frequency Distributions for Post Hoc Variables

Variable (Variable Name)	Survey Items and Response Options	Freq.	Weighted Freq.	%
Physical Abuse During Pregnancy (PAPG5_NO)	CDC Computed – no physical abuse during pregnancy	4,258	166,378	3.3
	C. No	108,417	4,870,388	96.7
	D. Yes			
Hospitalized During Pregnancy (HSP_PG5)	CDC Computed – hospitalized during pregnancy	88,059	4,415,708	87.7
	C. No	24,616	621,058	12.3
	D. Yes			
Kessner Index (KESSNER)	From birth certificate data – adjust the timing and quantity of prenatal care for length of gestation	84,500	3,865,436	76.7
	H. Adequate Prenatal Care	23,029	971,883	19.3
	I. Intermediate Prenatal Care	4,729	179,745	3.6
	J. Inadequate Prenatal Care	417	19,701	0.4
	K. Unknown Prenatal Care			
# of Prenatal Visits (PNC_VST_NAPHSIS)	From birth certificate data			
	F. 0-8 visits	24,286	813,230	16.1
	G. 9-11 visits	35,339	1,578,142	31.3
	H. 12 or more visits	53,050	2,645,393	52.5
Maternal Weight Gain During Pregnancy (MOMLBS)	From birth certificate data			
	O. Less than 10 lbs.	7,588	278,491	5.5
	P. 10 to 14 lbs.	6,742	245,049	4.9
	Q. 15 to 19 lbs.	8,947	347,670	6.9
	R. 20 to 24 lbs.	16,024	652,875	13.0
	S. 25 to 29 lbs.	16,157	719,286	14.3
	T. 30 to 34 lbs.	18,489	868,724	17.2
	U. 35 to 39 lbs.	12,287	616,316	12.2
	V. 40 to 44 lbs.	10,691	526,623	10.5
	W. 45 lbs. or more	15,750	781,732	15.5
First C-Section (DEL_1CS)	From birth certificate data			
	C. No	86,702	4,091,941	81.2
	D. Yes	25,973	944,824	18.8
Forceps Delivery (DEL_FORC)	From birth certificate data			
	C. No	111,475	4,981,248	98.9
	D. Yes	1,200	55,518	1.1

Repeated C-Section (DEL_RCS)	From birth certificate data H. No I. Yes	 99,674 13,001	 4,457,254 579,511	 88.5 11.5
Vacuum Delivery (DEL_VACM)	From birth certificate data C. No D. Yes	 108,432 4,243	 4,822,768 213,997	 95.7 4.2
Vaginal Delivery (DEL_VAG)	From birth certificate data F. No G. Yes	 40,339 72,336	 1,585,911 3,450,854	 31.5 68.5
Vaginal Delivery After C-Section (DEL_VCS)	From birth certificate data E. No F. Yes	 111,422 1,253	 4,980,825 55,940	 98.9 1.1
Adverse Pregnancy Outcomes	Occurrence of adverse pregnancy outcomes – number of outcomes experienced Possible adverse pregnancy outcomes include: - Birth defects - Plurality - Preterm delivery (less than or equal to 259 day/37 weeks) - Low birth weight (less than or equal to 2,500 grams) - Use of the Neonatal Intensive Care Unit (NICU) - Length of infant hospital stay (4 days or more) - Length of maternal hospital stay (4 days or more) - Small for gestational age (computed via algorithm) - Infant mortality E. 0 F. 1 G. 2 H. 3 I. 4 J. 5 K. 6 L. 7 M. 8	 52,542 19,190 13,585 7,169 7,499 9,344 3,048 274 24	 3,098,411 925,406 574,000 208,971 105,497 92,448 29.368 2,382 283	 61.5 18.4 11.4 4.1 2.1 1.8 0.6 0.0 0.0

Appendix C: Correlation Matrix for Post Hoc Analysis Variables

PROJECT 2 Post Hoc Analysis	Correlation Matrix										
	ABUSE DURING PREGNANCY	HOSPITALIZED DURING PREGNANCY	KESSNER INDEX	# OF PRENATAL CARE VISITS	MATERNAL WEIGHT GAIN DURING PREGNANCY	FIRST CESAREAN SECTION DELIVERY	FORCEPS ASSISTED DELIVERY	REPEATED CESAREAN SECTION DELIVERY	VACUUM ASSISTED DELIVERY	VAGINAL DELIVERY	VAGINAL DELIVERY AFTER PREVIOUS CESAREAN SECTION DELIVERY
ADVERSE PREGNANCY OUTCOMES	-0.028	0.338	0.030	-0.102	-0.027	0.330	-0.019	0.106	-0.033	-0.344	-0.021
INSURED	0.115	-0.040	-0.197	0.139	0.015	0.043	0.019	0.011	0.011	-0.044	-0.001
MEDICAID	-0.093	0.050	0.097	-0.075	-0.037	-0.040	-0.019	0.020	-0.018	0.019	0.008
INCOME	0.144	-0.066	-0.204	0.147	0.031	0.032	0.019	0.027	0.001	-0.047	0.007
EDUCATION	0.112	-0.033	-0.188	0.147	0.039	0.040	0.021	0.000	0.012	-0.034	-0.001
STRESS	-0.304	0.104	0.124	-0.076	0.005	-0.003	-0.008	-0.008	-0.006	0.010	-0.011
ABUSE BEFORE PREGNANCY	0.534	-0.055	-0.070	0.044	-0.008	0.012	0.011	0.005	-0.002	-0.014	0.002
ABUSE DURING PREGNANCY	1.000	-0.036	-0.055	0.043	0.005	0.012	0.002	0.002	-0.004	-0.009	-0.009
PREGNANCY – TRYING	0.092	-0.037	-0.142	0.098	0.002	0.031	0.012	0.010	0.013	-0.033	0.002
PREGNANCY - INTENTION	-0.023	-0.010	0.037	-0.035	-0.012	-0.056	-0.017	0.020	-0.015	0.030	0.021
MATERNAL AGE	0.103	-0.042	-0.136	0.097	-0.062	0.023	-0.004	0.142	-0.027	-0.125	0.044
HISPANIC ETHNICITY	0.028	0.008	-0.081	0.067	0.033	0.011	0.016	-0.015	0.013	0.003	-0.011
MATERNAL RACE	-0.041	0.009	0.084	-0.065	-0.028	0.004	-0.016	-0.001	-0.009	-0.003	0.004
PREGNANCY HISTORY	-0.021	0.068	0.032	-0.049	-0.129	-0.194	-0.048	0.261	-0.072	-0.031	0.080
BMI – UNDERWEIGHT	-0.016	0.012	0.025	-0.020	0.021	-0.034	0.008	-0.040	0.017	0.055	0.008
BMI – OVERWEIGHT	-0.011	0.041	-0.006	0.017	-0.189	0.086	-0.022	0.122	-0.030	-0.156	0.000
FOLIC ACID USE	0.083	-0.020	-0.097	0.071	0.023	0.040	0.009	0.003	0.005	-0.036	0.004
TOBACCO USE BEFORE PREGNANCY	0.098	-0.037	-0.052	0.027	-0.071	-0.014	-0.002	0.015	0.005	0.002	0.005
ALCOHOL FREQUENCY BEFORE PREGNANCY	0.036	0.021	0.054	-0.046	-0.074	-0.035	-0.017	0.040	-0.006	-0.001	0.017
BINGE DRINKING BEFORE PREGNANCY	0.049	0.015	0.043	-0.038	-0.076	-0.035	-0.018	0.043	-0.009	-0.003	0.018

Project 2 Post Hoc Analysis (continued)	**Correlation Matrix**										
TOBACCO USE DURING PREGNANCY	0.097	-0.029	-0.065	0.043	0.018	0.019	0.010	-0.009	0.011	-0.009	-0.005
ALCOHOL FREQUENCY DURING PREGNANCY	0.022	0.025	0.001	0.003	0.003	0.011	0.001	0.000	0.009	-0.008	-0.009
BINGE DRINKING DURING PREGNANCY	0.021	0.018	0.009	-0.002	0.005	0.004	-0.003	0.005	0.003	-0.005	-0.011
MATERNAL COMPLICATIONS	-0.086	0.398	0.016	-0.017	-0.066	0.060	-0.011	0.031	-0.021	-0.069	-0.007
HOSPITALIZED DURING PREGNANCY	-0.036	1.000									
PRENATAL EDUCATION	-0.003	0.025	0.024	-0.005	-0.005	0.029	-0.008	-0.028	0.005	-0.003	-0.017
PRENATAL CARE INITIATION	-0.059	-0.013	0.310	-0.225	-0.022	-0.050	-0.009	-0.020	-0.005	0.053	0.012
KESSNER INDEX	-0.055	0.013	1.000								
# OF PRENATAL CARE VISITS	0.043	-0.043	-0.615	1.000							
MATERNAL WEIGHT GAIN DURING PREGNANCY	0.005	-0.048	-0.063	0.084	1.000						
FIRST CESAREAN SECTION DELIVERY	0.012	0.075	-0.021	0.028	0.076	1.000					
FORCEPS ASSISTED DELIVERY	0.002	-0.012	-0.008	0.008	0.019	-0.043	1.000				
REPEATED CESAREAN SECTION DELIVERY	0.002	0.013	-0.007	-0.007	-0.047	-0.173	-0.027	1.000			
VACUUM ASSISTED DELIVERY	-0.004	-0.012	-0.013	0.010	0.018	-0.076	0.006	-0.041	1.000		
VAGINAL DELIVERY	-0.009	-0.071	0.021	-0.016	-0.030	-0.709	0.048	-0.532	0.070	1.000	
VAGINAL DELIVERY AFTER PREVIOUS CESAREAN DELIVERY	-0.009	-0.004	0.016	-0.017	-0.019	-0.051	0.001	-0.036	0.019	-0.137	1.000

About the Author

Maribeth Buie, a native Floridian, earned her B.S. degree in Biology from Florida Southern College, her M.S. degree in Pathology from the University of Florida, and her M.P.H. degree in Health Education from the University of South Florida. During her time at the University of South Florida, she served as an Instructor from 2004-2008 and as a Research Associate working with patient response to HPV, developing a pediatric IRB tutorial, and evaluating the Florida-based Right from the Start social advertising campaign.