CARDIOMETABOLIC RISK AND RISK PERCEPTION AMONG OKLAHOMA AMERICAN INDIAN WOMEN WITH PREVIOUS GESTATIONAL DIABETES

by

EMILY JEAN JONES

SUSAN APPEL, COMMITTEE CHAIR
YVONNE EAVES
LINDA MONEYHAM
ROBERT OSTER
FERNANDO OVALLE

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ABSTRACT

Introduction: Cardiovascular disease (CVD) is the number one killer of women in the United States (US). Increasing rates of CVD have been associated with the epidemic rates of type 2 diabetes mellitus (T2DM) in the US. Minority women, particularly American Indian women, experience a greater burden of health risk factors and significant disparities in health status related to CVD and T2DM. Furthermore, women who have had gestational diabetes mellitus (GDM) during pregnancy are at greater risk for these diseases than women who have not had GDM. However, these women often do not perceive themselves to be at risk, or, if they do, they often do not possess the self-efficacy to carry out lifestyle behaviors that would decrease their risk.

Article Synthesis: The first published article included in this dissertation, titled Type 2 Diabetes – Fueling the Surge of Cardiovascular Disease in Women (Jones & Appel, 2008), describes the cardiometabolic risk conferred by T2DM and CVD and provides a foundational review for the two articles that follow. With a more narrow scope, the second published article included, titled, A Review of the Health Beliefs and Lifestyle Behaviors of Women with Previous Gestational Diabetes (Jones, Roche, & Appel, 2009) examines the health beliefs, risk perceptions, and health behaviors related to diet and physical activity of women with previous GDM (pGDM). Finally, the third article, titled, A Mixed Methods Investigation of Cardiometabolic Risk and Risk Perception among Oklahoma American Indian Women with Previous Gestational Diabetes describes a pilot
study which examines the cardiometabolic risk factors, risk perceptions, and self-efficacy beliefs of Oklahoma American Indian women with pGDM. The final article addresses gaps in the literature related to the estimation of cardiometabolic risk among American Indian women with pGDM and the description of knowledge, risk perceptions, and self-efficacy beliefs related to prevention of T2DM and CVD. Findings from the descriptive mixed methods study presented in this final article contribute to the growing body of nursing knowledge related to health disparities and women’s cardiometabolic health.

Key words: cardiometabolic risk, gestational diabetes, type 2 diabetes, cardiovascular disease, risk perception, mixed methods
DEDICATION

I dedicate this dissertation to my husband, Rusty,
whose consistent encouragement and competitive spirit
have inspired me to achieve great things.
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I would be remiss if I did not take this opportunity to thank my dad, Paul Moore, for igniting the spark that eventually led me to UAB to pursue a PhD in Nursing. I remember well the late night phone call that started it all. Also, I am forever indebted to my mom, Carolyn Moore, for instilling such self-confidence and determination in her daughters. Finally, I thank my husband, Rusty Jones, for his unwavering support and encouragement.
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INTRODUCTION

Cardiovascular disease (CVD) affects 42.1 million women over 20 years of age in the United States (US) and is the leading cause of mortality in women in the US, accounting for one in every 2.6 deaths (American Heart Association [AHA], 2009). Adults with diabetes are two to four times more likely to die from CVD than their nondiabetic counterparts (AHA). Type 2 diabetes (T2DM) confers even greater risk for macrovascular disease in women than in men (Fagan & Deedwania, 1998). In recent years, T2DM has been designated a major cardiovascular risk equivalent, described as the risk for a coronary event, such as a myocardial infarction (MI), which is similar between an individual with diabetes and no history of a MI and an individual without diabetes with a history of a previous MI (NCEP, 2001). In addition, women are at increased risk for CVD and associated mortality compared to men related to their higher rates of obesity, hypertension, and atherogenic dyslipidemia (Juutilainen et al., 2004).

Cardiometabolic risk describes an individual’s level of risk for developing T2DM and/or CVD. This construct comprises a cluster of modifiable and nonmodifiable factors useful for predicting a patient’s overall risk for the development of both or either of these conditions (American Diabetes Association [ADA], 2006). There is an unmistakable need to identify effective ways to decrease rates of cardiometabolic disease in women.
Gestational Diabetes Mellitus: A Cardiometabolic Risk Factor

Each year in the US, over 200,000 women (about 7% of all pregnant women) are diagnosed with gestational diabetes mellitus (GDM), a form of glucose intolerance diagnosed during pregnancy (ADA, 2004) and a recognized cardiometabolic risk factor (Retnakaran et al., 2010). Women with previous GDM (pGDM) have a 20% to 50% chance of developing T2DM in the next five to ten years (ADA; National Institute of Diabetes and Digestive and Kidney Diseases [NIDDKD], 2005). According to a recent systematic review of the literature, incidence of T2DM was highest among minority populations including American Indian women with pGDM (Kim, Newton, & Knopp, 2002). Women with pGDM are at increased risk for developing CVD, independent of a diagnosis of T2DM (Bentley-Lewis, 2009; King, Gerich, Guzick, King, & McDermott, 2009; Shaw, Retnakaran, & Booth, 2008; Rivero, Portal, & Vieira, & Behle, 2008). One study showed that, within just 11 years of the index pregnancy, women with pGDM have a 70% increased incidence of CVD compared with their peers (Shaw et al.). Several factors are considered responsible for promoting CVD in women with pGDM including T2DM, hypertension, inflammation, endothelial dysfunction, and dyslipidemia (Bentley-Lewis; King et al.).

Insulin resistance is a normal physiological response during pregnancy, a carbohydrate-intolerant state; in the majority of pregnancies, the demand for more insulin is readily met. However, high-risk ethnic groups such as American Indian women are predisposed to dominant insulin resistance in pregnancy, leading to GDM (Ben-Haroush, Yogev, & Hod, 2004). Research shows that conditions associated with insulin resistance, such as GDM, may predispose women to hypertension, hyperlipidemia, high levels of
plasminogen activator inhibitor-1, leptin, and tumor necrosis factor-alpha. These conditions are associated with increased risk of CVD (Solomon & Seely, 2001). Following pregnancy, many American Indian women with pGDM will develop impaired glucose tolerance that will ultimately lead to the development of T2DM and, potentially, to CVD.

**Rising Rates of Cardiovascular Disease and Diabetes in American Indians**

Native Americans are often mistakenly viewed as a single ethnic minority population; however, they are a culturally and politically diverse population of American Indians and Alaska Natives representing 562 federally recognized tribes and numerous tribes and communities that are not federally recognized (Caldwell et al., 2005; US Department of the Interior, 2009; Galloway, 2005). Approximately four million American Indians and Alaska Natives reside in the US, making up 1.4% of the total population (US Census Bureau, 2007). As a group, Native Americans experience excess morbidity and mortality compared to the US general population (Young, 1997).

It is essential to understand the impact of cardiometabolic disease among American Indians. In recent decades, CVD has become the leading cause of death among American Indian and Alaska Native men and women, as well as a major cause of disability (Indian Health Service [IHS], 2004). The Strong Heart Study, a longitudinal epidemiological study of cardiovascular risk factors among American Indians, reports that the incidence of CVD in American Indians is two times higher than the rates for the general US population (Howard et al., 1999). The rate of decline of CVD mortality among Native Americans has been relatively slow since 1972 with almost no decline.
from 1989 to 1997. This is starkly contrasted with the substantial declines in CVD
mortality reported for the total US population since the early 1970s (IHS). In the early
1970s, CVD death rates for Native Americans were 21% lower than the total US
population; by the late 1990s, however, they were 20% higher (IHS). In addition to the
disproportionate rates of prevalence of CVD in this population, Native Americans also
die from CVD at younger ages than other racial and ethnic groups in the US. Over one-
third of those who die from CVD die before the age of 65 (Oh et al., 2004).

Increasing rates of CVD are attributed in part to the increasing rates of diabetes in
this population (Howard et al., 1999). Prior to World War II, diabetes was uncommon in
Native Americans. Recent research, however, shows that an estimated 9.7% of this
population has diabetes compared with 5.7% of non-Native American populations in the
US (Denny, Holtzman & Cobb, 2003). In the Strong Heart Study, diabetes was the
strongest determinant of CVD among all risk factors examined with 56% of
cardiovascular events in men and 78% of events in women occurring in persons with
diabetes (Howard et al., 1999). During 1994 to 2002, the overall age-adjusted prevalence
of diabetes for Native Americans was more than twice that of US adults overall (Acton,
Burrows, Geiss & Thompson, 2003). Data collected by the IHS from 1994-2004
indicated that the age-adjusted prevalence of diagnosed diabetes increased from 8.5 to
17.1 per 1,000 population among Native Americans under the age of 35 who used IHS
healthcare services. During this time, prevalence of diabetes was greater among females
than males in all age groups. In addition, Native American females aged 25-34 years had
the greatest annual percentage change of diagnosed diabetes (9.1%) among all age groups
(Acton, Burrows, Wang & Geiss, 2006).
**Cardiovascular Disease Burden in American Indian Women**

American Indian women represent a geographically, socially, and culturally diverse group of women with varying rates of incidence of CVD and prevalence of associated risk factors (Howard et al., 1999; Struthers, Baker & Savik, 2006; Welty et al., 1995). Disparities in cardiovascular health status exist between American Indian women and non-Hispanic White women evidenced by disproportionate CVD death rates. From 1996-1998, the CVD death rate for American Indian women aged 35-44 was 26.3 per 100,000 population while the death rate for US White women was 12.8 per 100,000. Among women aged 45-54 years, CVD death rates were 89.7 and 44.9 per 100,000 for American Indian and White women, respectively; among women aged 55-64 years, death rates were 278 and 162.5 per 100,000 for American Indian and White women, respectively (IHS, 2004).

Recent research also reveals that American Indian women experience a greater burden of health risk factors and chronic diseases than African American, Hispanic and Asian women in the US (Liao, Tucker & Giles, 2003). Data from the Racial and Ethnic Approaches to Community Health (REACH) 2010 Risk Factor Survey, 2001-2002, reveal a 13.0% prevalence rate of CVD in American Indian women compared to prevalence rates of 9.4%, 5.6% and 5.5% in African American, Hispanic and Asian women, respectively (Liao et al.). According to the data from REACH 2010, American Indian women experienced greater prevalence of obesity, current smoking, and diabetes than African American, Hispanic and Asian women. Prevalence rates of hypertension and high cholesterol were slightly higher among African American women. Prevalence of more than three CVD risk factors was 33.3% in American Indian women, compared to
26.7%, 15.5% and 4.8% in African American, Hispanic and Asian women, respectively (Liao et al.). Unlike other racial and ethnic groups, the incidence of CVD continues to increase among American Indian women, and coronary events are more often fatal among this population (Howard et al., 1999; Oh et al., 2004).

**Cardiovascular Risk Factors in American Indian Women**

Two studies conducted in the last two decades, the Strong Heart Study and the Inter-Tribal Heart Project, collected extensive data on CVD risk factors in American Indians residing within the Southwestern US and the Northern Plains. The Strong Heart Study examined CVD risk factors among 13 tribes in Arizona, Oklahoma, North Dakota and South Dakota while the Inter-Tribal Heart Project examined CVD risk factors in American Indians residing on three reservations in Minnesota and Wisconsin. These studies revealed high prevalence of insulin resistance syndrome, hypertension, elevated cholesterol levels, diabetes, lower extremity arterial disease, renal injuries, and low levels of physical activity – all risk factors for CVD (Casper et al., 1996; Fischer et al., 1999; Greenlund, Valdez, Casper, Rith-Najarian & Croft, 1999; Howard et al., 1995; Howard et al., 1996; Kasiske, Rith-Najarian, Casper & Croft, 1998; Lamar-Welch, Casper, Greenlund, Zheng, Giles & Rith-Najarian, 2002; Lee et al., 1995; Struthers, Savik & Hodge, 2004; Welty et al., 1995).

The Strong Heart Study revealed that the incidence of CVD and CVD risk factors in American Indians varied by region studied; however, in the total cohort of women, diabetes, age, obesity, low density lipoprotein cholesterol, albuminuria, triglycerides, and hypertension were found to be significant independent predictors of CVD (Howard et al.,
1999). The Strong Heart Study revealed higher incidence rates of fatal CVD in American Indians living in Arizona as opposed to those living in Oklahoma, North Dakota or South Dakota. This finding is consistent with the greater prevalence rates of diabetes, hypertension, and albuminuria among American Indians living in Arizona (Howard et al.). In a recent secondary data analysis that examined CVD risk factors among American Indian women who participated in the Inter-Tribal Heart Project, age, diabetes and hypertension were found to be significant predictors of CVD (Struthers et al., 2006).

**Risk Perception and Self-Efficacy**

The Diabetes Prevention Program, a major multicenter clinical research study, revealed that women with pGDM can lower their risk for developing T2DM by practicing lifestyle behaviors aimed at reducing weight and increasing physical activity (Ratner et al., 2008). However, women who have been diagnosed with GDM often do not perceive themselves to be at risk for developing T2DM or CVD, even if they understand the association between these disease states (Hjelm, Berntorp, Frid, Aberg, & Apelqvist, 2008; Kim et al., 2007). Individuals’ knowledge, perceptions of risk, and self-efficacy beliefs are significant predictors of health-related behaviors (Kim et al.; Rimal & Real, 2003). Therefore, it is essential to gain an understanding of American Indian women’s risk perceptions for developing T2DM and CVD, as well as their self-efficacy beliefs related to preventing future disease, prior to the development and implementation of lifestyle interventions which serve to increase women’s risk awareness, promote healthy lifestyle behaviors, and prevent progression to cardiometabolic disease.
Article Synthesis

The first published article included in this dissertation, titled *Type 2 Diabetes – Fueling the Surge of Cardiovascular Disease in Women* (Jones & Appel, 2008), describes the cardiometabolic risk conferred by T2DM and CVD and provides a foundational review for the two articles that follow. Providing a more narrow focus, the second published article included in this dissertation, titled, *A Review of the Health Beliefs and Lifestyle Behaviors of Women with Previous Gestational Diabetes* (Jones, Roche, & Appel, 2009) examines the health beliefs, risk perceptions, and health behaviors related to diet and physical activity of women with pGDM. Findings from this review were integral in the design of the dissertation mixed methods study described in the third article. This article, titled, *A Mixed Methods Investigation of Cardiometabolic Risk and Risk Perception among Oklahoma American Indian Women with Previous Gestational Diabetes* describes a pilot study which examines the cardiometabolic risk factors, knowledge, risk perceptions, and self-efficacy beliefs of Oklahoma American Indian women with pGDM. The final article addresses paucity in the literature related to the estimation of cardiometabolic risk among American Indian women with pGDM and the description of knowledge, risk perceptions, and self-efficacy beliefs related to prevention of cardiometabolic disease. Findings from the descriptive mixed methods study presented in this final article contribute to the growing body of nursing knowledge related to health disparities and women’s cardiometabolic health.
TYPE 2 DIABETES – FUELING THE SURGE OF CARDIOVASCULAR DISEASE IN WOMEN

by

EMILY J. JONES AND SUSAN J. APPEL

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Format adapted for dissertation
Objectives

Upon completion of this activity, the learner will be able to:

1. Recognize and identify the interrelated risk factors that contribute to the development of type 2 diabetes and cardiovascular disease (CVD) in women.

2. Formulate strategies that result in the early identification of women at risk for developing type 2 diabetes and CVD.


Continuing Nursing Education (CNE) Credit

A total of 2 contact hours may be earned as CNE credit for reading “Type 2 Diabetes: Fueling the Surge of Cardiovascular Disease in Women” and for completing an online post-test and participant feedback form.

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Introduction

Diabetes mellitus (DM) is a global and national concern, estimated to have affected 171 million people worldwide in 2000 and projected to rise to 366 million by 2030 (Wild, Roglic, Green, Sicree, & King, 2004). Approximately 20.8 million Americans have diabetes (7 percent of the population), approximately 30 percent of whom are unaware of their diagnosis (American Heart Association [AHA], 2007).

DM is a group of metabolic diseases characterized by hyperglycemia resulting from impairments in insulin secretion, insulin action or both (American Diabetes Association [ADA], 2007). The most common form of DM is type 2 diabetes, formerly called adult-onset diabetes or non-insulin dependent diabetes, which is characterized by a combination of insulin resistance and an inadequate compensatory response to secrete more insulin, resulting from beta-cell failure (ADA, 2008). Type 2 diabetes accounts for 90 to 95 percent of DM cases and is the more preventable form of DM (ADA, 2008).

Type 2 diabetes and cardiovascular disease (CVD) share many genetic, behavioral and environmental risk factors, and it’s clear that the diabetes epidemic is fueling the CVD epidemic. Adults with diabetes are two to four times more likely to die from CVD, including coronary heart disease (CHD), stroke, congestive heart failure and sudden cardiac death, than their nondiabetic counterparts (AHA, 2007). This increased cardiovascular risk is explained in great part by the metabolic abnormalities that both precede type 2 diabetes and remain in effect during the natural course of the disease (Fonseca, 2003). These abnormalities and subsequent risk factors form the well-described
pathway known as the metabolic syndrome, which ultimately leads to cardiovascular injury or death (National Cholesterol Education Program [NCEP], 2001). Before discussion of the implications of the risk factors inherent in the metabolic syndrome as well as other relevant traditional and nontraditional risk factors, it’s important to understand the impact of diabetes on women.

**Women and the Diabetes Epidemic**

While the prevalence of diabetes is higher among men, more women than men actually have diabetes in the U.S. (Wild et al., 2004); this may be related to women’s longer life expectancies. In 2004, 7.9 million females were living with diabetes as diagnosed by their physicians, compared with 7.3 million males, and 37,800 females died from diabetes compared with 35,000 males (AHA, 2007). Cardiovascular diseases are the leading cause of death among women in the U.S., accounting for 1 in every 2.6 deaths (AHA). Diabetes increases the risk for developing macrovascular disease four- to fivefold among women compared with twofold increase in men (Fagan & Deedwania, 1998). It appears that women may, therefore, forfeit the cardioprotective features of their estrogen in the presence of diabetes (Fagan & Deedwania).

Recent advances in cardiology and pharmacologic therapies have resulted in decreased cardiovascular mortality among nondiabetic women and men with CVD (Fonseca, 2003). Among self-reporting U.S. adults with diabetes, there has been a well-documented decrease in cardiovascular mortality among men in the past 25 years; however, no decreases in mortality are present among women. In fact, the difference between mortality rates among women with diabetes and without diabetes doubled during
this time period (Gregg, Gu, Cheng, Narayan, & Cowie, 2007). The fact that diabetic women have not benefited from the changes that significantly improved the CVD outlook for diabetic men and nondiabetic men and women is alarming and demands the attention of nurses and other health professionals caring for women.

**Gender Disparities**

There has been recent discussion regarding possible explanations for why women experience higher rates of cardiovascular mortality related to diabetes than their male counterparts (Duggirala et al., 2005; Gregg et al., 2007; Lee, Cheung, Cape, & Zinman, 2000; Legato et al., 2006). Gender disparities are identified within the literature as falling into three distinct categories: (1) pathophysiology, (2) treatment/medical management and (3) contextual risk factors.

**Pathophysiology**

Research suggests that there are gender differences in the pathophysiology of CHD evidenced by a greater tendency among women to develop CHD and left ventricular hypertrophy. Also, women may present with different inflammatory and hormonal responses to risk factors and manifest more complicated patterns of symptoms than men, potentially resulting in higher mortality rates (Gregg et al., 2007). Diabetic women likely suffer from a heavier risk factor burden than do men; they experience more obesity, hypertension and atherogenic dyslipidemia, thus increasing their risk for CVD and associated mortality (Juutilainen et al., 2004).
**Treatment/Medical Management**

Evidence suggests that the treatment and medical management of diabetes in women differs from that in men (Gregg et al., 2007; Wenger, 2007). Medical management of diabetes has been described as less aggressive among women (Duggirala et al., 2005; Gregg et al., Legato et al., 2006), manifesting in fewer preventative interventions prior to the development of CVD and fewer guideline-based therapies at hospital admission and after discharge following an acute cardiac event (Wenger). While there has been a documented increase in the use of antihypertensives and aspirin in adults at risk for CVD, the increase is not as significant among women (Gregg et al.). Also, lipid control is worse in women (Wenger), as is blood pressure control (Duggirala et al.). Diagnoses of CHD tend to be less accurate among women (Gregg et al.), and when women are diagnosed with CHD, it is consistently later in the course of the disease (Wenger). These disparities in the treatment and medical management of diabetes among women could certainly contribute to their higher mortality rates.

**Contextual Risks**

The third category of gender disparities is that of contextual risk for developing CVD. Contextual risk factors have been defined as circumstances or variables beyond the control of the individual that ultimately may increase morbidity and/or mortality for diseases such as CVD (Appel, Giger & Davidhizar, 2005; Appel, Harrell & Deng, 2002). A major example of contextual risk factor is socioeconomic status (SES), consisting of numerous variables such as income, education, marital status and geographic location. The literature consistently supports the assertion that contextual risk factors can adversely
affect women’s cardiovascular health (Black, 2002; Mensah, Mokdad, Ford, Greenlund & Croft, 2005).

These three categories of gender disparities will be addressed further as we consider major risk factors predisposing women to both type 2 diabetes and CVD.

**Risk Factors**

The literature reveals three interrelated spheres of risk factors that contribute to the development of type 2 diabetes and/or CVD: (1) genetics, (2) environment and (3) metabolic abnormalities (see Figure 1). It’s often a combination of these risk factors, like interlinking pieces in a puzzle, that hastens the onset of the disease among women. To implement appropriate interventions for the prevention and treatment of type 2 diabetes among women, an understanding of the risk factors predisposing women to this disease is imperative.

**Genetic Factors**

Although research has not elucidated a single gene that alone is responsible for the development of type 2 diabetes, there are many findings in the literature that support the genetic hypothesis. However, it’s likely that several genes interacting with the environment serve to foster the development of diabetes. These findings include a nearly 100 percent concordance rate of diabetes among identical twins, aggregation of the disease in families and the higher rates of prevalence of diabetes among certain ethnic and racial groups (Fletcher, Gulanick, & Lamendola, 2002; Meigs, Cupples, & Wilson, 2000). The Framingham Offspring Study explored the rates of occurrence of diabetes
among offspring with parental diabetes and offspring without parental diabetes. Results showed that among offspring with a single diabetic parent, the risk for developing type 2 diabetes was 3.5-fold higher than among individuals without a diabetic parent; among offspring with two diabetic parents, the risk of developing type 2 diabetes was six times higher (Meigs et al.).

**Age**

Formerly called adult-onset or maturity-onset diabetes, the prevalence of type 2 diabetes has historically increased with age. However, environmental aspects such as a sedentary lifestyle and the obesity epidemic have resulted in increasing numbers of young adults and children being diagnosed with type 2 diabetes during the past decade (Fletcher et al., 2002). To fully address this epidemic in society, it’s no longer appropriate to consider type 2 diabetes an adult disease. The risk factor of age is further compounded by genetic risk. In addition, it’s apparent that the age of an individual at the time of the development of this disease is a product of environment and lifestyle. Screening for type 2 diabetes should increase as the individual ages. Once an individual is over age 45, the ADA recommends yearly screening for type 2 diabetes and more frequently if symptoms are present.

**Ethnicity and Race**

The higher prevalence rates for type 2 diabetes among minority ethnic and racial groups provide strong evidence for a genetic component of the disease (Abate & Chandalia, 2003; Black, 2002; Fletcher et al., 2002). It’s well established that people of
African American, Hispanic, Pacific Islander, Asian American and Native American heritages experience higher rates of type 2 diabetes—two to six times greater than that of their Caucasian counterparts (Fletcher et al.).

Members of minority groups are at higher risk for developing type 2 diabetes not only because of genetics but also because of the “urbanization/westernization” of their environments, which results in decreased physical activity and diets lower in fiber and higher in calories, saturated fats and processed carbohydrates (Abate & Chandalia, 2003; Fletcher et al., 2002; Leahy, 2005). There appears to be a distinct linkage, therefore, between genetics and environment that is especially notable among various ethnic groups. Environmental factors that can alter glucose homeostasis directly influence whether or not an individual will develop the type 2 phenotype (Leahy). It has been hypothesized that the increasing rates of type 2 diabetes in the U.S. are in part due to the changing ethnic composition of the population (Abate & Chandalia). This is an area of research that demands more attention as culturally appropriate strategies are developed for the prevention and treatment of type 2 diabetes among minority populations.

**Lifestyle and Environment**

It’s clear that environment or lifestyle factors play a major role in the development of type 2 diabetes. Although women cannot change their genetic makeup, they can be empowered to take an active part in altering environmental factors which predispose them to type 2 diabetes and CVD.
The modern lifestyle of women in the United States, composed of high-calorie diets and lack of physical activity, contributes to obesity, a state in which many if not all of the elements of dysglycemia or an abnormal glucose levels begin to manifest (Astrup & Finer, 2000; Gregg et al., 2005; Leahy, 2005; Rader, 2007). The literature consistently reveals that body mass index (BMI) and physical activity are significant predictors of type 2 diabetes (Eckel, Kahn, Robertson, & Rizza, 2006; Field et al., 2004; Mokdad et al., 2001). Nearly two-thirds of U.S. adults are either overweight or obese (Eckel et al.). The National Heart, Lung, and Blood Institute (NHLBI, 1998) defines overweight as a BMI of 25-29.9 kg/m$^2$ and obese as a BMI of $\geq$ 30 kg/m$^2$. Such a strong association has been established between obesity and diabetes that the term “diabesity” has been coined within the literature in the past decade (Abate & Chandalia, 2003; Astrup & Finer). Research shows that merely being overweight carries many of the same complications of obesity (Field et al.; Mokdad et al.). A woman who is “apple-shaped” or has an increased waist circumference (i.e., $>35$ inches or $>32$ inches among Asian women) and, therefore, has excess adipose tissue stored intra-abdominally, is at higher risk for developing type 2 diabetes and other cardiovascular related diseases than her “pear-shaped” female counterparts (Appel & Bannon, 2007; Astrup & Finer; Klein et al., 2007). There have been estimates that 80 percent to 90 percent of all type 2 diabetes cases can be accounted for by obesity and/or overweight along with an abdominal fat distribution (Astrup & Finer).

The literature reveals a direct relationship between obesity and mortality among women (Manson et al., 1995; Mokdad et al., 2001, 2003). Research from the Prospective
Nurses Health Study (1976-1992) revealed that a 10-kg weight gain in a woman after the age of 18 was associated with increased mortality as a middle-aged adult. However, no significant changes in mortality were found when women had lost weight or gained < 10 kg of weight. Interestingly, Manson et al. found that a woman’s BMI at age 18 was a predictor of mortality related to CVD and of overall mortality in middle-adulthood. This supports prevention and intervention strategies regarding obesity among children and adolescents.

The risk for type 2 diabetes increases when obesity is compounded by physical inactivity (Fletcher et al., 2002; Leahy, 2005; Weinstein et al., 2004). Current guidelines suggest that for optimal cardiovascular health, individuals should participate in moderate exercise for 30 to 45 minutes a day, on most days of the week. However, despite these recommendations, 75 percent of adults in the U.S. only engage in minimal physical activity, such as walking 15 to 20 minutes a day or less, on a regular basis (Fletcher et al.). Obesity and sedentary lifestyles set women up to develop the metabolic syndrome and begin the downward spiral to full-blown diabetes and CVD.

**Socioeconomic Status**

In the U.S. population, there is an inverse relationship between SES and prevalence of obesity and type 2 diabetes (Abate & Chandalia, 2003). An analysis of four cross-sectional national surveys revealed that between 1971 and 2002, diabetes prevalence increased most among people with low incomes and education (Kanjilal et al., 2006). While there has been significant success reducing CVD risk factors overall in the U.S. over the past 30 years, this success has not been equally distributed among all
segments of society (Kanjilal et al.). Lower SES and less access to high-quality health care, factors that have a greater prevalence among minorities than whites, predispose already at-risk women to type 2 diabetes (Appel et al., 2002; Black, 2002, Fletcher et al., 2002).

There is evidence that poor maternal nutrition during pregnancy, related to SES factors such as poor access to prenatal care, can create an undernourished uterine environment resulting in low birthweight. This low birthweight is accompanied by permanent changes in structure and function in the fetus that predispose to type 2 diabetes as well as other cardiovascular-related diseases in adulthood (Abate & Chandalia, 2003). Because of the impact of low SES and not genetics alone, individuals can acquire risk factors for disease before they’re ever born. The impact of SES on risk for disease is an area of research that demands attention by nurses caring for women and infants.

**Metabolic Factors**

The metabolic abnormalities that contribute to the development of type 2 diabetes and CVD among women have been given well-deserved attention in the last decade, contributing to a better understanding of the pathophysiology associated with the diseases. Discussion in this section will be focused on metabolic abnormalities shown to predispose women to type 2 diabetes and CVD, including prediabetes, metabolic syndrome, insulin resistance, gestational diabetes mellitus (GDM) and polycystic ovary syndrome (PCOS).
**Pre diabetes**

Preceding the diagnosis of type 2 diabetes, many women may display either impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) (see Table 1). The presence of either IFG or IGT is categorized as “prediabetes” by the ADA (2006). Prediabetes may occur up to 10 to 20 years prior to the manifestation of type 2 diabetes, and, when individuals have prediabetes, they may begin to develop macrovascular CVD (macrovascular refers to diseases of the large blood vessels). Therefore, identifying even mild dysglycemia (abnormal blood glucose) is of utmost importance for preventing the development of type 2 diabetes.

**Metabolic Syndrome**

Metabolic syndrome is a cluster of closely related risk factors for type 2 diabetes and/or CVD (see Box 1). Over the past few years more than four definitions of metabolic syndrome have been established. Although the definition of metabolic syndrome is still evolving, the one most commonly used clinically within the United States is from the NCEP Adult Treatment Panel III (ATP III). NCEP (2001) defines the metabolic syndrome in women as three or more of five abnormalities: waist circumference >35 inches, triglycerides ≥150 mg/dL, high-density lipoprotein cholesterol (HDL-C) <50 mg/dL, blood pressure ≥ 130/85 mmHg and fasting glucose ≥ 100 mg/dL (see Table 1). There are differing definitions and criteria for this constellation of risk factors; however, the goal of designating the syndrome as such is to increase the numbers of individuals identified as at risk for developing type 2 diabetes and/or CVD (Alberti, Zimmet, & Shaw, 2005; Hall et al., 2006; Wilson, D’Agostino, Parise, Sullivan, & Meigs, 2005). The
literature indicates that an additional criterion of insulin resistance could assist in identifying increased numbers of women as having metabolic syndrome (Appel, 2006; Appel et al., 2005; Meigs et al., 2007). This is especially relevant to black women, in whom dyslipidemia often does not manifest as early as it does among white or Hispanic women, thus decreasing their identification as having metabolic syndrome (Appel et al.).

Metabolic syndrome has been proven predictive for new-onset type 2 diabetes beyond glucose intolerance alone (Lorenzo, Williams, Hunt, & Haffner, 2007; Wilson et al., 2005). Once an individual has been diagnosed with type 2 diabetes, the presence of the metabolic syndrome is associated with a 3.8-fold increased risk for developing CHD and other CVD (Hall et al., 2006). It has been estimated that as many as 75 percent of people with type 2 diabetes manifest the metabolic syndrome (Bruno et al., 2004; Hall et al.). It’s also clear that this combination confers the greatest risk for CHD (Alexander, Landsman, Teutsch, & Haffner, 2003). Because risk factors tend to cluster, if one component of the metabolic syndrome is identified, it’s prudent to assess for other risk factors to identify at-risk women early and implement appropriate intervention strategies to decrease associated morbidity and mortality. Central abdominal obesity is often an early clue to the impending presence of the metabolic syndrome and emerging risk for type 2 diabetes.

**Insulin Resistance**

Insulin resistance, defined as impaired insulin-mediated glucose clearance into target tissues, is a metabolic abnormality linked to the development of type 2 diabetes and CVD and a key feature of the metabolic syndrome (Leahy, 2005). Insulin resistance
plays a pivotal role in the pathophysiology of several metabolic abnormalities present in the syndrome, including high triglycerides, low HDL-C, hypertension, abnormal fibrinolysis (i.e., risk for thrombus formation) and coronary artery disease (CAD) (Fonseca, 2003). The body tissues most affected by the defect of insulin resistance include the skeletal muscle, liver, adipose tissues and endothelium (Caballero, 2004; Leahy).

Abdominal obesity contributes greatly to the development of insulin resistance, and recent studies have shed light on the pathophysiology of this link between the two (Fujimoto, 2000; Hsueh, 2003; Rader, 2007). Rather than only having the function of storing triglycerides, it’s known that fat cells produce proteins called adipokines that have peripheral effects on skeletal muscle and hepatic tissues, thus affecting insulin sensitivity (Hsueh; Leahy, 2005; Rader).

One clinically helpful way of measuring insulin resistance is through the use of the homeostatic model assessment of insulin resistance (HOMA\textsubscript{IR}), which was developed by Matthews et al. in 1985 (Appel, 2005). This formula calculates insulin resistance in the following way:

\[
\text{HOMA}_{\text{IR}} = \frac{\text{fasting insulin (mU/L)} \times \text{fasting glucose (mmol/L)}}{22.5}
\]

Risk for type 2 diabetes and CVD increases as insulin resistance progresses to IGT then to impaired fasting glucose IFG (Fletcher et al., 2002; Nathan et al., 2007; Rader, 2007). It has been established that insulin resistance is a silent condition that precedes the development of overt diabetes by a significant amount of time; in this time,
the risks for CVD begin to mount (Caballero, 2004; Nathan et al.; Rader). For this reason, it’s now recommended that clinicians begin aggressive treatment in patients who present with insulin resistance, before IGT or IFG manifest, and before the presence of overt type 2 diabetes and/or CVD (Rader).

**Gestational Diabetes Mellitus**

GDM is a metabolic abnormality that complicates approximately 7 percent of all pregnancies and is characterized by hyperglycemia of varying severity with onset or first recognition during pregnancy (ADA, 2004a; Chirayath, 2006). The definition of GDM encompasses both type 1 and type 2 diabetes identified during pregnancy as well as other lesser degrees of dysglycemia (i.e., IGT), which most often return to normal after pregnancy (ADA; Chirayath).

There are many different recommendations in the literature regarding screening for GDM and currently no consensus exists. The American College of Obstetricians and Gynecologists (ACOG) recommends a 50-g, 1-hour oral glucose challenge for all pregnant women at 24 to 28 weeks gestation (ACOG, 2001). ACOG states that the recommendation is based on limited evidence and allows that although universal screening is the most sensitive strategy, certain women at low risk are less likely to benefit from testing. Cut-offs of either 140 or 130 mg/dL may be used to determine women who are candidates for a diagnostic glucose tolerance test (GTT). ACOG cites the 100-g, 3-hour oral GTT as the diagnostic test in pregnancy that has the most supporting evidence. Two or more abnormal values are required on this test to make the diagnosis of gestational diabetes. The ADA (2004a, 2004b) recommends risk assessment at the first
prenatal visit, followed by glucose screening as soon as possible if the patient presents with obesity, glycosuria, a history of GDM, a family history of diabetes or any other risk factors characteristic of high risk for GDM. If no abnormalities are present at that time, then follow-up screening is recommended at 24 to 28 weeks of gestation. Women at average risk are also to be screened at 24 to 28 weeks of gestation, and women of low risk (required to meet certain criteria) do not require screening (ADA, 2004a, 2004b). GDM is diagnosed with a fasting plasma glucose level > 126 mg/dL or a casual plasma glucose level > 200 mg/dL, confirmed on a subsequent day (ADA, 2004a).

Women diagnosed with GDM are at increased risk for developing type 2 diabetes after pregnancy. This risk is further increased if the woman is obese or displays other metabolic risk factors that promote insulin resistance (Albareda et al., 2005; Ben-Haroush, Yogev, & Hod, 2004). Although the ADA recommends screening of women with a history of GDM for type 2 diabetes at six weeks postpartum, then periodically thereafter, research suggests that such screening opportunities are being missed (Kim et al., 2006). Because pregnancy often serves as a stress-test for cardiometabolic disease, nurses caring for women should take full advantage of this opportunity to provide education regarding future CVD risk and implement interventions that promote prevention and early treatment of diabetes and other cardiovascular-related diseases.

**Polycystic Ovary Syndrome**

PCOS, affecting 5 percent to 10 percent of premenopausal U.S. women, is the most common endocrine disorder among women of reproductive age (Dokras et al., 2005). Women with PCOS are considered to be at increased risk for developing type 2
diabetes related to underlying insulin resistance (Barber, McCarthy, Franks, & Wass, 2007; Caballero, 2005). The same factors that cluster in the metabolic syndrome are frequently present among women with PCOS, suggesting a common etiology (Barber et al.; Dokras et al., 2005). Research has shown that women with PCOS have an 11-fold increase in the prevalence of metabolic syndrome compared with age-matched controls (Dokras et al.). Because women are diagnosed with PCOS at relatively young ages, this condition also provides a unique opportunity to screen for type 2 diabetes and future CVD.

**Prevention and Treatment**

The literature consistently supports that therapeutic lifestyle changes are the first line of defense for preventing and treating type 2 diabetes and CVD (NCEP, 2001). When lifestyle changes are not enough, pharmacologic management should be considered. The following sections will highlight important strategies clinicians should utilize in order to successfully prevent or manage type 2 diabetes and CVD in women.

**Therapeutic Lifestyle Changes**

The recent success of major intervention trials clearly indicates that high-risk individuals can be identified and type 2 diabetes delayed, if not prevented (ADA, 2004b, 2006; Knowler et al., 2002). In the early stages of cardiovascular risk, lifestyle modification with attention to moderate weight loss (5 percent to 10 percent of body weight) and moderate physical exercise (30 minutes daily) may be sufficient to
dramatically reduce progression to type 2 diabetes (ADA, 2004a, 2004b, 2006; Astrup & Finer, 2000; Donner, 2006; Eckel et al., 2006; Hall et al., 2006; Rader, 2007).

There is wide agreement in the literature that overweight and obesity are the main preventable and treatable causes of type 2 diabetes (Astrup & Finer, 2000; Eckel et al., 2006), and, for this reason, the ADA and AHA give clinical priority to the overweight/obese patient in the quest to prevent and manage type 2 diabetes (Eckel et al., 2006). Rather than only prescribing diets, such as the Mediterranean diet (Opie, 2007), which are intended to improve glycemic control and blood lipids, clinicians should prescribe diets intended to promote weight loss (Astrup & Finer, 2000). Regular physical exercise is an essential element in addressing metabolic abnormalities that predispose for diabetes, because it increases glucose metabolism by muscle, assists in weight loss, decreases triglycerides and low-density lipoprotein cholesterol (LDL-C), raises HDL-C, lowers blood pressure and decreases insulin resistance (Hall et al., 2006; Nathan et al., 2006; Opie; Ryan, 2000).

The Diabetes Prevention Program revealed that lifestyle changes including weight loss and physical exercise were almost twice as effective as the drug metformin in preventing diabetes (ADA, 2006; Knowler et al., 2002). In the early stages of metabolic abnormalities, prior to the utilization of pharmacotherapy, weight management strategies should be considered the cornerstone of therapeutic lifestyle changes in the prevention of type 2 diabetes and utilized accordingly (Astrup & Finer, 2000, Hall et al., 2006, Rader, 2007).

It should be noted that recent research reveals that bariatric surgery can improve glucose metabolism and insulin resistance in morbidly obese patients, thus, in effect,
reversing the affects of type 2 diabetes. The mechanisms by which bariatric surgery improves type 2 diabetes are controversial, but have been proposed to include caloric restriction, weight loss, decrease in fat mass and a resulting decrease in circulating adipokines, which affect insulin sensitivity (Gumbs, Modlin, & Ballantyne, 2005).

Unfortunately, lifestyle programs focused on weight management without surgery and physical activity have limited long-term success maintaining glycemic goals in patients with overt type 2 diabetes. For this reason, a large majority of patients will require the addition of pharmacotherapy over the course of their diabetes (Donner, 2006; Nathan et al., 2006).

**Pharmacologic Management**

There is no “one size fits all” plan for the pharmacologic management of patients with prediabetes or overt diabetes. Therapeutic decisions must be individualized for each patient according to her needs (ADA, 2006; Appel, Wright, & Ovalle, 2007; Donner, 2006). Pharmacologic treatment plans focusing on the prevention or management of type 2 diabetes and associated CVD often consist of a combination of medications. Those medications that are most utilized include antihyperglycemics, insulin, antilipidemics and antihypertensives.

**Antihyperglycemic medications.** The primary goal of therapy with antihyperglycemic medications is to achieve and maintain glucose levels as close to the nondiabetic range as possible (Nathan et al., 2006). The ADA’s most recent glycemic goal recommendation is a HbA1c (A1C) level < 7% (Nathan et al.). Research indicates that patients who had an A1C ≥ 7% had three times the risk of having a CHD event than
patients with A1C levels < 7% (Bohannon, 2003). In a position statement by the ADA regarding a consensus algorithm for the initiation and adjustment of therapy in the management of hyperglycemia in patients with type 2 diabetes, it’s recommended that an A1C of ≥ 7% should indicate that it’s time to initiate or change antihyperglycemic therapy (Nathan et al.). Guidelines in this position statement emphasize achievement and maintenance of normal glycemic goals; initial therapy with lifestyle interventions and metformin; rapid addition of medications and transition to new regimens when target glycemic goals are not achieved or sustained; and early addition of insulin therapy in patients who do not meet target goals (Nathan et al.).

The rationale behind the ADA’s recommendation to initiate metformin, a biguanide, at the time of initial therapy with lifestyle changes is that for most patients with type 2 diabetes, as well as carefully chosen patients with prediabetes, lifestyle programs often fail to bring about or maintain metabolic goals. This failure is related to a combination of factors, including failure to lose weight, weight regain or progressive disease (Nathan et al., 2006). For its glucose-lowering effects, metformin is recommended by the ADA as the initial pharmacologic therapy (Nathan et al.). When used alone it seldom results in weight gain or hypoglycemia, and it has a low level of side effects and a relatively low cost (Donner, 2006; Nathan et al.). Metformin has also been shown to have lipid-lowering properties, especially related to lowering triglycerides, and reducing insulin resistance, one of the primary pathologies of type 2 diabetes (Hall et al., 2006).

The ADA considers it reasonable to compare different glucose-lowering medications “primarily on the basis of the A1C levels that are achieved and on their
specific side effects, tolerability, and expense” (Nathan et al., 2006, p.1965). For this reason, the consensus algorithm for treatment of hyperglycemia includes the classes of sulfonylureas and thiazolidinediones (TZDs or glitazones), along with insulin, related to their glucose-lowering effectiveness, but excludes pramlintide, exenatide, alpha-glucosidase inhibitors and the glinides due to their generally lower effectiveness, limited clinical data and cost. However, the ADA acknowledges that these drugs may be quite therapeutic among some patients (Nathan et al.).

It is worth noting that TZDs have been shown in several studies to have a favorable effect on blood pressure, vascular and coagulation defects, lipid abnormalities and beta cell function, thus potentially making this class a good candidate for combination therapy with the goal of addressing cardiometabolic risk factors rather than glycemic control alone (Appel et al., 2007; Braunstein, 2003; Fonseca, 2003; Meriden, 2004). The combination of a TZD with a biguanide, such as metformin, has been shown to improve insulin sensitivity and lower blood glucose, thus also affecting cardiometabolic risk (Braunstein).

However, in November of 2007, the Food and Drug Administration (FDA) issued a black box warning on rosiglitazone (a TZD) related to potential increased risks of myocardial ischemic events, especially among patients who already have heart disease. This followed earlier warnings issued in May and June of 2007 regarding these potential risks (FDA, 2007). There is no conclusive evidence that increased risks exist, due in part to a lack of statistical power in some of the studies reviewed by the FDA (ADA, 2007). Currently, several more studies are underway to determine the cardiovascular risks associated with this class of oral antihyperglycemics. TZDs currently remain on the
market, and the ADA and the American Association of Clinical Endocrinologists (AACE) state that clinical judgment is to be used by the practitioner in the selection of all medications (AACE, 2007; ADA).

Oral antihyperglycemics have generally not been recommended during pregnancy because of their potential harmful effects on the fetus. Glyburide, however, is one oral agent that does not cross the placenta and has been shown in one randomized, unblinded clinical trial to achieve perinatal outcomes similar to those achieved by insulin in women past the first trimester of pregnancy at the time of initiation of therapy (ADA, 2004). However, glyburide has not been approved by the FDA for the treatment of GDM, and furthermore, it lacks the dosing and timing specificity of insulin. Insulin is regarded as the primary pharmacologic therapy to initiate in pregnancy when blood glucose levels cannot be regulated with diet and lifestyle modification alone (ADA).

**Insulin therapy.** Research shows that beta-cell function may have already decreased to 50 percent by the time a patient is diagnosed with type 2 diabetes; therefore, many patients will require insulin therapy in order to achieve optimal glycemic control (Appel et al., 2007; Bohannon, 2003; Donner, 2006). It’s important to remember that insulin resistance is present long before the diagnosis of diabetes is made, and hyperinsulinemia is merely a physiologic response to insulin resistance. Elevated fasting insulin concentrations (indicating insulin resistance) have been established as very good predictors of ischemic heart disease (Bohannon). To reduce morbidity and mortality associated with the poor glycemic control inherent in type 2 diabetes, it’s imperative to understand the vitality of insulin therapy.
The recommendation to initiate insulin therapy early in patients who don’t meet target goals with oral antidiabetic agents is a recent one (Appel, 2005; Nathan et al., 2006). Adding insulin to oral antidiabetic therapy has been shown to decrease A1C levels by 1 to 2.5 percent (Donner, 2006). Also, insulin has anti-inflammatory and vasodilator properties, increasing its ability to combat cardiovascular risk factors (Hall et al., 2006).

Recommendations for insulin regimes suggest a combination of basal-bolus and basal-prandial insulin therapy to achieve glycemic goals (Appel et al., 2007). Basal insulin is the amount of insulin needed to maintain glucose control between meals, while prandial insulin is the amount needed to cover the rise in blood glucose after a meal. Combination basal-prandial insulin therapy mimics the function of the pancreas, thus making it a more effective way of maintaining glycemic control (Appel et al.).

**Antilipidemics.** Among patients with insulin resistance, abnormalities in lipid metabolism are among the major risk factors for CVD (Rader, 2007). For this reason, the ADA recommends aggressive treatment of dyslipidemia in patients with diabetes (ADA, 2006). Recent recommendations in the literature also include aggressive targets for lipid management among prediabetic patients (patients with IFG or IGT) in order to prevent or delay overt disease (Rader). The ADA recommends lipid management focused on lowering LDL-C, raising HDL-C and mildly lowering triglycerides, as these three actions have been shown to reduce macrovascular disease and mortality in patients with diabetes (ADA). See Box 2 for specific lipid targets for women with diabetes.

When lifestyle modifications are not sufficient to meet lipid goals, pharmacologic management is necessary (ADA, 2006; Rader, 2007). The ADA recommends lowering LDL-C to target levels as the first priority in pharmacologic therapy (ADA). For this,
Statins are the preferred first choice. Statins also may reduce triglycerides and result in modest increases in HDL-C, and, therefore, are considered the foundation of most lipid-modifying approaches. Other drugs to be considered for LDL-lowering include nicotinic acid, ezetimibe, bile acid sequestrants, fenofibrate and fish oil (ADA; Hall et al., 2006).

To address raising HDL and lowering LDL and triglycerides concurrently, a fibric acid derivative, niacin or fish oil should be considered (ADA, 2006; Rader, 2007). Because of niacin’s propensity for increasing blood glucose levels when given at high doses, it’s recommended that modest doses (750-2000 mg/day) be given in order to exert a beneficial effect on the lipid profile without exerting harm (ADA; Hall et al., 2006).

**Antihypertensives.** Hypertension, a major risk factor for CVD and microvascular complications such as retinopathy and nephropathy, is a common comorbidity of diabetes (ADA; Fonseca, 2003). The incidence of hypertension is approximately two times higher among patients with diabetes compared to their nondiabetic counterparts (Fonseca). The ADA recommends that patients with diabetes and blood pressure ≥ 140/90 mmHg should receive drug therapy in addition to lifestyle modification. Often it requires a combination of antihypertensive medications to achieve blood pressure targets. The ADA recommends that initial antihypertensive therapy include drugs from classes that have demonstrated a reduction in CVD events in patients with type 2 diabetes, including ACE inhibitors, angiotensin II receptor blockers (ARBs), beta-blockers, diuretics and calcium channel blockers (CCBs) (ADA). However, some research indicates that beta-blockers and diuretics should be avoided related to the fact that they are more likely to foster metabolic syndrome than other antihypertensives (Opie, 2007).
The ADA recommends that all patients with type 2 diabetes and hypertension be treated with either an ACE inhibitor or an ARB, as these classes have been shown to delay the progression of nephropathy as well as the progression of CVD (ADA, 2006; Fonseca, 2003). They also lessen the risk for new diabetes (Opie, 2007). These classes, however, are contraindicated during pregnancy. Antihypertensives to be considered during pregnancy include methyldopa, labetalol, diltiazem, clonidine and prazosin (ADA).

Conclusion

It’s clear that the development of type 2 diabetes and CVD among women is dependent upon a synergistic combination of risk factors from interrelated spheres including genetics, environment and metabolic abnormalities. Because the outcomes associated with type 2 diabetes and CVD in women are inferior to the outcomes in men, there is great need for nurses who care for women to prioritize strategies that result in early identification of women at risk for these diseases. It’s also imperative to implement intervention strategies for the prevention and treatment of type 2 diabetes and CVD, including lifestyle modification and pharmacologic therapy, in order to decrease the high rates of prevalence of these diseases in women and the associated morbidity and mortality.
References


diabetes with lifestyle intervention or metformin. *New England Journal of Medicine, 346*(6), 393-403.


Figure 1 – Interrelated Spheres of Risk Factors for Developing Type 2 Diabetes and/or CVD Among Women
Table 1 – Assessment of Glucose Homeostasis

<table>
<thead>
<tr>
<th>Glucose Level</th>
<th>Terminology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fasting</strong></td>
<td></td>
</tr>
<tr>
<td>&lt;100 mg/dL</td>
<td>EUGLYCEMIA</td>
</tr>
<tr>
<td>100 to 125 mg/dL</td>
<td>IMPAIRED FASTING GLUCOSE</td>
</tr>
<tr>
<td>&gt;126 mg/dL</td>
<td>DIABETES MELLITUS OR GESTATIONAL DIABETES MELLITUS (IF FIRST DIAGNOSED IN PREGNANCY)</td>
</tr>
<tr>
<td><strong>Glucose level after a 2-hour post oral glucose tolerance test (OGTT)</strong></td>
<td></td>
</tr>
<tr>
<td>140 to 199 mg/dL</td>
<td>IMPAIRED GLUCOSE TOLERANCE</td>
</tr>
<tr>
<td>&gt;200 mg/dL</td>
<td>DIABETES MELLITUS OR GESTATIONAL DIABETES MELLITUS (IF FIRST DIAGNOSED IN PREGNANCY)</td>
</tr>
<tr>
<td><strong>Prediabetes</strong></td>
<td></td>
</tr>
<tr>
<td>100 to 125 mg/dL</td>
<td>IMPAIRED FASTING GLUCOSE</td>
</tr>
<tr>
<td>140 to 199 mg/dL</td>
<td>IMPAIRED GLUCOSE TOLERANCE</td>
</tr>
</tbody>
</table>

Source: ADA, 2004b.
Box 1 – Components of Metabolic Syndrome

**BOX 1  COMPONENTS OF METABOLIC SYNDROME**

- Central obesity
- Atherogenic dyslipidemia, indicated by elevated triglycerides, small low-density lipoprotein (LDL) particles and low high-density lipoprotein (HDL) cholesterol
- Hypertension
- Hyperglycemia
- Hyperinsulinemia
- Insulin resistance
- Dysfibrinolysis, indicated by increased levels of plasminogen activator inhibitor-1 [PAI-1]
- Inflammation, indicated by increased levels of C-reactive protein (CRP)

Sources: Alberti et al., 2005; Bonow & Gheorghiade, 2004; Hall et al., 2006; Miranda, DeFronzo, Califf & Guyton, 2005; NCEP, 2001; Ridker, Buring, Cook & Rifai, 2003.

Box 2 – Blood Lipid Goals for Women with Diabetes

**BOX 2  BLOOD LIPID GOALS FOR WOMEN WITH DIABETES**

- LDL-C <100 mg/dL
- HDL-C >50 mg/dL
- Triglycerides <150 mg/dL

Sources: ADA, 2006; Rader, 2007.
Post-Test Questions

1. Type 2 diabetes accounts for what percentage of patients with diabetes?
   a. 55 to 60 percent
   b. 70 to 75 percent
   c. 90 to 95 percent

2. The increased cardiovascular risk experienced by diabetic patients compared to their nondiabetic counterparts is best explained by:
   a. contextual risk factors such as socioeconomic status.
   b. metabolic abnormalities that both precede type 2 diabetes and remain in effect during the course of the disease.
   c. uncontrolled blood glucose levels experienced by many diabetic patients.

3. Which of the following populations has not benefited from the changes that significantly improved the CVD outlook of other populations?
   a. diabetic men
   b. diabetic women
   c. nondiabetic women

4. The three overarching, interrelated spheres of risk factors that contribute to the development of type 2 diabetes, as described by the ADA, include:
   a. environment, genetic and metabolic abnormalities
   b. family history, age and ethnicity
   c. obesity, sedentary lifestyle and socioeconomic status

5. The literature reveals a direct relationship between cardiovascular related mortality and which of the following in women?
   a. elevated blood glucose levels
   b. elevated cholesterol levels
   c. obesity

6. The American Diabetes Association defines “prediabetes” as existing when the following states are present:
   a. dysfibrinolysis and inflammation.
   b. elevated LDL and decreased HDL cholesterol.
   c. impaired fasting glucose and/or impaired glucose tolerance

7. Inflammation, a risk factor inherent in the metabolic syndrome, is indicated by increased levels of:
a. c-reactive protein
b. fasting blood glucose
c. plasminogen activator inhibitor-1

8. Which of the following is a silent condition that commonly occurs within the general population of women and precedes the development of overt diabetes by as much as a decade?

a. gestational diabetes mellitus
b. insulin resistance
c. polycystic ovary syndrome

9. It is recommended that women with a history of gestational diabetes mellitus be screened for which of the following diseases six weeks postpartum and then periodically thereafter?

a. cardiovascular disease
b. type 1 diabetes mellitus
c. type 2 diabetes mellitus

10. The first line of defense for preventing and treating type 2 diabetes and CVD consists of:

a. oral antihyperglycemic medications.
b. insulin therapy
c. therapeutic lifestyle changes.

11. The American Diabetes Association’s most recent glycemic goal recommendation is a HbA1c level of which of the following?

a. < 6%
b. < 7%
c. < 8%

12. Recent recommendations by the American Diabetes Association related to the management of hyperglycemia in patients with type 2 diabetes emphasize that initial therapy consist of lifestyle interventions and which antihyperglycemic medication?

a. exenatide
b. metformin
c. pramlintide

13. Which of the following has anti-inflammatory and vasodilator properties?

a. glinides
b. insulin
c. sulfonylureas

14. When lifestyle modifications are not sufficient to meet lipid targets among patients with type 2 diabetes, the American Diabetes Association recommends which of the following as the first priority in pharmacological therapy?

a. lowering LDL-C to target levels
b. lowering triglycerides to target levels
c. raising HDL-C to target levels

15. The American Diabetes Association recommends that, in patients with type 2 diabetes, antihypertensive medication should be initiated in addition to lifestyle changes in patients with a blood pressure greater than or equal to which of the following?

a. 130/85 mmHg
b. 140/85 mmHg
c. 140/90 mmHg

Answer Key:

1) c
2) b
3) b
4) a
5) c
6) c
7) a
8) b
9) c
10) c
11) b
12) b
13) b
14) a
15) c
A REVIEW OF THE HEALTH BELIEFS AND LIFESTYLE BEHAVIORS OF WOMEN WITH PREVIOUS GESTATIONAL DIABETES

by

EMILY J. JONES, CATHY C. ROCHE, AND SUSAN J. APPEL


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Format adapted for dissertation
Abstract

Objective: To critically review and synthesize original research designed to examine the health beliefs, including risk perceptions and health behaviors related to diet and physical activity of women with previous gestational diabetes mellitus.

Data Sources: PubMed and CINAHL databases were searched for studies published in the last decade (1998-2008) that examined variables related to the health beliefs and behaviors of women with previous gestational diabetes mellitus. Keyword searches included health beliefs, health behaviors, perceived risk, gestational diabetes, type 2 diabetes, diet, physical activity, and postpartum.

Study Selection: Eight articles, representing 6 studies, were selected that met the inclusion criteria of original research, dependent variable of health beliefs and behaviors of women with previous gestational diabetes mellitus, and measurement after pregnancy.

Data Extraction: Articles were reviewed and discussed according to the concepts of risk perception and health beliefs, health behaviors related to diet and physical activity, and psychosocial factors related to women’s health beliefs and behaviors.

Data Synthesis: Data revealed common health beliefs and behaviors of women with previous gestational diabetes mellitus, including low risk perceptions for future type 2 diabetes mellitus and suboptimal levels of physical activity and fruit and vegetable intake. The majority of studies revealed a distinct knowledge-behavior gap among women with previous gestational diabetes mellitus, whereas others revealed a lack of knowledge regarding necessary lifestyle modifications.
Conclusions: Findings from this review may assist women’s health researchers and clinicians in developing appropriate interventions for increasing risk awareness, promoting self-efficacy for weight loss and physical activity behaviors, and decreasing rates of diabetes and cardiovascular disease among women with previous gestational diabetes mellitus. Further research is necessary to identify factors that influence the health beliefs and behaviors of women with previous gestational diabetes mellitus. Future research should focus on populations of greater racial, ethnic, and socioeconomic diversity, as the majority of studies have been conducted with non-Hispanic White, socioeconomiclly advantaged women.
Each year in the United States, over 200,000 women (about 7% of all pregnant women) are diagnosed with gestational diabetes mellitus (GDM), a form of glucose intolerance diagnosed during pregnancy (American Diabetes Association [ADA], 2004). Women with previous GDM (pGDM) have a 20% to 50% chance of developing type 2 diabetes mellitus (T2DM) in the next 5 to 10 years, and the prevalence may be higher depending on race (ADA; National Institute of Diabetes and Digestive and Kidney Diseases. National Institutes of Health, 2005). A systematic review of the literature showed that the cumulative incidence of T2DM among women with pGDM ranged from 2.6% to 70% in studies that examined women 6 weeks to 28 years postpartum (Kim, Newton, & Knopp, 2002).

A study using data for nonpregnant women (N = 155,911) from the 2003 Behavioral Risk Factor Surveillance System, a survey of health risk factors sponsored by the Centers for Disease Control, found that women with pGDM (n = 2,123) were more likely to possess modifiable risk factors for developing T2DM, such as physical inactivity, overweight, and obesity than their counterparts without pGDM (Yun, Kabeer, Zhu, & Brownson, 2007). The Diabetes Prevention Program, a major multicenter clinical study aimed at discovering whether modest weight loss through dietary changes and increased physical activity or treatment with the oral diabetes medication metformin could prevent or delay the onset of T2DM, revealed that women with pGDM can lower their risk for developing T2DM by losing weight and increasing physical activity (Knowler et al., 2002).
The Impact of Diabetes and Cardiovascular Disease (CVD) in Women

Cardiometabolic health is a term promoted by the ADA to describe an individual’s level of risk for developing T2DM and CVD; cardiometabolic risk is a construct that comprises a cluster of modifiable and nonmodifiable factors that are predictive indicators of a patient’s overall risk for the development of both or either of these conditions (ADA, 2006). The metabolic abnormalities that accompany GDM, and both precede T2DM and remain in effect during the natural course of the disease, place women at high risk for CVD (Fonseca, 2003). Cardiovascular diseases are the leading cause of death among women in the United States, accounting for 1 in every 2.6 deaths (American Heart Association [AHA], 2009). Adults with diabetes are two to four times more likely to die from CVD, including coronary heart disease, stroke, congestive heart failure, or sudden cardiac death, than their nondiabetic counterparts (AHA). Type 2 diabetes increases the risk for developing macrovascular disease four- to fivefold among women compared with twofold increase in men (Fagan & Deedwania, 1998).

Type 2 diabetes is recognized as a major cardiovascular risk equivalent (National Cholesterol Education Program. ATPIII, 2001). The risk for a coronary event such as a myocardial infarction (MI) is similar between an individual with diabetes and no history of an MI and an individual without diabetes with a history of a previous MI. Among women, it appears that the diagnosis of diabetes without any prior evidence of coronary heart disease indicates greater cardiovascular risk than prior evidence of coronary heart disease in nondiabetic individuals (Juutilainen, Lehto, Ronnemaa, Pyorala, & Laakso, 2005). Women also experience more obesity, hypertension, and atherogenic dyslipidemia than men, resulting in increased risk for CVD and associated mortality (Juutilainen et al.,
2004). Given these serious consequences, it is clear that women with pGDM represent a population in which early intervention can and should be targeted in order to decrease rates of T2DM and CVD.

The Significance of Health Beliefs and Behaviors

In the last decade, researchers have given much attention to the risk for developing T2DM among women with pGDM. Comparatively little attention has been devoted to the risk perceptions, health beliefs, and health behaviors among women with pGDM. Health beliefs are defined as “the personal convictions that influence health behaviors,” whereas health behavior is “an action taken by a person to maintain, attain, or regain good health and to prevent illness” (Anderson, Keith, & Novak, 2002, p. 784). Research has shown that women with pGDM often do not perceive themselves to be at elevated risk for developing T2DM, even if they recognize that GDM is a risk factor for T2DM (Hjelm, Berntorp, Frid, Aberg, & Apelqvist, 2008; Kim et al., 2007b). Women’s health researchers and clinicians should recognize that individuals’ health beliefs and risk perceptions are significant predictors of health-related behaviors (Brown & Morley, 2007; Kaptein et al., 2007; Kim et al.).

Before the successful implementation of interventions that serve to increase women’s risk awareness, promote healthy lifestyle behaviors, and prevent progression to T2DM, researchers and clinicians must recognize the common risk perceptions, health beliefs, and behaviors of women with pGDM. To the authors’ knowledge, this review is the first to synthesize original research examining the risk perceptions, health beliefs, and behaviors related to diet and physical activity of women with pGDM.
Theoretical Foundations

Three well-known theoretical models were identified to provide a framework for examining the risk perceptions, health beliefs, and health behaviors related to diet and physical activity of women with pGDM. The Health Belief Model attempts to predict health behaviors by understanding the health beliefs and attitudes of individuals; it suggests that risk perception may greatly determine health behavioral change (Becker, 1976). The key constructs of this model include perceived susceptibility (risk), perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy (Becker; Green, 2002). According to this model, women with pGDM who perceive themselves to be at risk of developing T2DM would be more likely to practice behaviors that would decrease their risk, such as a healthy diet and regular physical activity. Conversely, women who do not perceive themselves to be at risk might be less likely to practice these important lifestyle behaviors. Critics of the Health Belief Model feel that it accounts only for predisposing factors enabling behavior initially and does not account for those factors enabling and reinforcing behavior over time (Green).

The Transtheoretical Model, also called the stages of change model, has informed the development of numerous interventions to facilitate health-related behavior change in the past two decades and is considered by many to be the dominant model of health behavior change (Armitage, 2009). The model describes five stages of a person’s readiness to change a problem behavior. The first two stages, precontemplation and contemplation, include individuals who do not intend to change or who recognize the problem and are seriously considering change, respectively. The third stage, preparation for action, includes individuals who intend to change behavior within the next month and
may have already initiated some behavioral changes. The last two stages, action and maintenance, include individuals who have enacted consistent behavioral change for less than 6 months or for 6 months or more, respectively (Prochaska & Velicer, 1997). According to this model, women with pGDM who recognize the need to increase physical activity and intend to change within the next month would be in the preparation for action stage. Interventions among these women would be aimed at increasing self-efficacy for initiating and maintaining physical activity.

The Theory of Planned Behavior suggests that performance of a given behavior is a joint function of intentions and perceived behavioral control. Intentions are informed by individuals’ prominent behavioral (advantages), control (barriers), and normative (social influences) beliefs (Ajzen, 1991; Symons Downs & Ulbrecht, 2006). In order for an individual to adopt a given behavior, the individual must possess both actual and perceived behavioral control. Actual behavioral control refers to an individual’s access to both resources and opportunities to perform a given behavior, whereas perceived behavioral control, similar to the concept of self-efficacy, refers to an individual’s perception of the ease or difficulty of performing the behavior of interest (Ajzen). According to this model, the number of favorable behavioral, control, and normative beliefs related to diet and physical activity of women with pGDM would likely be associated with their intentions and subsequent levels of physical activity or diet behaviors.

Methods

A systematic review of the literature was conducted using two databases: PubMed
and CINAHL. Various combinations of the keywords health beliefs, health behaviors, perceived risk, gestational diabetes mellitus, type 2 diabetes, diet, physical activity, and postpartum were used for the search. The database searches were limited to English language articles published between 1998 and 2008 that studied human participants. The following inclusion criteria were used: original research, dependent variable of health beliefs and/or behaviors of women with pGDM, and measurement of women’s health beliefs and/or behaviors after pregnancy.

The first search was conducted in PubMed and yielded 328 original research articles that included the search terms. The second search of CINAHL yielded 136 articles of which 85 were duplicates of the PubMed search. After the databases were searched, two authors identified and reviewed the abstracts of articles considered appropriate for further examination. The PubMed search produced 8 articles that met criteria for inclusion in the review, whereas the CINAHL search produced 7 of these 8 articles and no additional articles. The articles by Smith, Cheung, Bauman, Zehle, and McLean (2005) and Zehle et al. (2008) represent one original as do the articles by Kim et al., 2007a,b. In total, 8 articles (representing 6 original studies) were identified for inclusion in this review.

**Review**

This review will begin with an overview of the designs and focal areas of the 6 studies followed by the results and major findings according to the concepts of risk perception and health beliefs, health behaviors of diet and physical activity, and psychosocial factors related to women’s health beliefs and behaviors. Finally, the
discussion of the findings presents clinical implications and future directions for research concerning the prevention of T2DM in women with pGDM.

*Designs*

Descriptive, cross-sectional, retrospective designs were used in all 6 studies included in this review (Feig, Chen, & Naylor, 1998; Kieffer, Sinco, & Kim, 2006; Kim et al., 2007a,b; Smith et al., 2005; Swan, Kilmartin, & Liaw, 2007; Symons Downs & Ulbrecht, 2006; Zehle et al., 2008). The descriptive designs address a gap in the literature and reflect a common purpose to examine and describe various health beliefs and behaviors related to diet and physical activity of women with pGDM.

*Focal Areas*

Based on the idea that preventive health behaviors depend largely on an individual’s risk perception, two studies reviewed examined risk perceptions for T2DM among women with pGDM (Kim et al., 2007b; Swan et al., 2007). In addition, Swan et al. examined readiness to prevent future diabetes in a cohort of rural women with pGDM. Five of the studies reviewed examined the health behaviors of women with pGDM. Symons Downs and Ulbrecht (2006) examined specific beliefs and behaviors related to exercise in the postpartum period, whereas Kieffer et al. (2006) investigated the outcome measures of meeting physical activity and fruit and vegetable guidelines in an effort to identify common health behaviors in women with and without pGDM. Zehle et al. (2008) and Smith et al. (2005) analyzed the influence of psychosocial factors, including self-efficacy, on diet and physical activity behaviors, respectively, in Australian women
with pGDM. Kim et al. (2007a) examined the association between recall of provider recommendations for T2DM prevention and health behaviors among women with pGDM. Feig et al. (1998) examined the association between self-perceived health status and diabetes preventive behaviors of Canadian women 3 to 5 years after the diagnosis of GDM.

The studies selected for this review represent several different approaches for examining the risk perceptions, health beliefs, and behaviors of women with pGDM. When synthesized, the results from these 6 studies elucidate important knowledge useful for informing the development of intervention strategies aimed at decreasing rates of cardiometabolic disease among women with pGDM. The 8 articles included in this review are summarized in Table 1.

**Results**

*Risk Perceptions, Health Beliefs, and Perceptions of Health Status*

Women’s risk perceptions, health beliefs, and perceptions of health status are important factors that may influence whether or not women with pGDM will practice weight loss and/or physical activity behaviors postpartum. Kim et al. (2007b) examined the associations between risk perceptions and current health behaviors, plans to modify those behaviors, and recent changes of health behaviors in women with pGDM (N = 217). The authors found that only 16% of women believed that they had a high chance of developing T2DM, despite the fact that 90% of women recognized GDM as a risk factor for future diabetes. When asked to estimate their risk for developing T2DM assuming they maintained their current lifestyle, the percent of women who believed they had a
high chance of developing diabetes increased to 39% (Kim et al.). Consistent with the Health Belief Model (Becker, 1976), greater risk perception was associated with more frequent plans to modify future lifestyle behaviors including diet and physical activity. Longitudinal studies are necessary to determine if women’s intentions to improve health behavior translate into actual behavioral change. The cross-sectional design of this study limits the ability to make this determination. Overall, this study showed incongruence between knowledge and increased risk perception of diabetes risk factors. Further, even though the majority of women intended to increase physical activity and improve diet in the near future, less than one third reported the recommended levels of physical activity and optimal fruit and vegetable consumption. Another study revealed that despite increased perceptions of risk and a high awareness of prevention strategies for T2DM, the prevalence of physical activity and healthy diet behaviors was low in a population of rural, Australian women with pGDM (N = 53; Swan et al., 2007). This study reveals a distinct gap between increased risk perception, knowledge of prevention strategies, and improved lifestyle behaviors in this at-risk population.

Symons Downs and Ulbrecht (2006) specifically examined the health beliefs of women with pGDM regarding the perceived advantages, barriers, and important social influences related to exercise (N = 28). In the postpartum period, the strongest perceived advantage of exercise was controlling weight, whereas during pregnancy it was glycemic control. The most common barrier to exercise postpartum was insufficient time, whereas during pregnancy it was fatigue. Women reported more exercise postpartum than during pregnancy, and they reported that their husbands or partners had the strongest social influence on them regarding exercise during pregnancy and postpartum. The authors
found that the self-reported number of behavioral beliefs (exercise advantages) was positively associated with women’s exercise behavior during pregnancy and postpartum (Symons Downs & Ulbrecht). In a sample of 226 women, Smith et al. (2005) also found that the most common barrier to physical activity in the postpartum period was insufficient time; however, the women in this sample also reported a lack of assistance with child care as a major barrier.

Perceptions of health status are conceptually similar to risk perceptions for future disease. In a sample of 65 women with pGDM and 197 matched controls, Feig et al. (1998) examined the self-perceived health status of women 3 to 5 years after the diagnosis of GDM. The authors found that compared with matched controls, women with pGDM were more worried about their own health, rated their children as less healthy, and perceived themselves to be at increased risk for T2DM. However, increased worry did not translate into preventive lifestyle behaviors in this sample of women. Kieffer et al. (2006) also found that women with pGDM reported worse self-rated health than women without pGDM. These studies, like others discussed above, revealed incongruence between women’s increased risk perception, poor self-perceived health status, and improved health behavior.

**Health Behaviors**

*Diet and weight loss behavior.*

The mean body mass index (BMI) of the participants in all 6 studies selected for review was classified as either overweight (BMI = 25-29.9 kg/m2) or obese (BMI>30 kg/m2; see Table 2). This finding suggests the need to consider weight loss an obvious
target for intervention in order to decrease women’s risk for developing cardiometabolic disease. Four of the studies reviewed examined diet and weight loss behaviors of women with pGDM. In each of these studies, the authors found that women had an inadequate daily intake of fruits and vegetables. Further, the authors identified a gap between the women’s knowledge and their diet and weight loss behaviors (Kieffer et al., 2006; Kim et al., 2007a, b; Swan et al., 2007; Zehle et al., 2008).

Kim et al. (2007b) found that only 31% of women with pGDM (N = 217) reported consuming the recommended five or more servings of fruit and vegetables per day, and 40% reported having fewer than three servings per day. Kim et al. (2007a) reported that the majority of women with pGDM recalled receiving counseling regarding necessary lifestyle modification, including diet and weight loss behaviors; however, no significant associations existed between recall of advice and change in dietary behaviors.

Kieffer et al. (2006) found that 87% of the women with pGDM (n = 4,718) who lived with children under the age of 18 years were significantly less likely to meet fruit and vegetable consumption guidelines (odds ratio 0.78 [95% confidence interval 0.63-0.97]; p<.05) and more likely to smoke (1.21 [1.01-1.47]; p<.05) than women without pGDM. In a sample of 226 women, Zehle et al. (2008) found that only 5% of the women consumed the recommended five servings of vegetables per day, whereas 38% consumed one serving or less of vegetables per day. Forty-four percent of women reported consuming the recommended two or more servings of fruit per day; half of the cohort reported drinking full-fat milk, and 26% of the women reported eating fried food at least twice per week. Women who spoke a non-English language at home reported poorer dietary practices compared with English-speaking women. One third of women reported
not knowing which foods would reduce their risk of developing diabetes (Zehle et al.).

This study revealed a lack of knowledge regarding preventive health behaviors among women with pGDM.

The pilot study conducted by Swan et al. (2007) revealed that 40 of 53 women were classified in the pre-action stage for weight loss, indicating that they were either not ready to change, ambivalent about behavior change, or ready to make a change within the next month but not currently practicing weight loss behaviors. Because of the small sample and for purposes of comparative analyses, the authors divided respondents into two groups: “pre-action,” including the women in precontemplation, contemplation, and preparation stages, and “action,” including the women in action and maintenance stages of the Transtheoretical Model. The study revealed that only 11 of 44 women were classified in the action stage for weight loss, indicating that they had either recently implemented weight loss behaviors or were successfully maintaining weight loss behaviors. Just under half of the women were currently not engaged in any therapeutic lifestyle behaviors to reduce their risk for T2DM, including diet or weight loss behavior.

**Physical activity behavior.**

Five of the studies reviewed examined the physical activity behaviors of women with pGDM. In each of these studies, the authors found that women’s physical activity levels were suboptimal, and many authors identified incongruence between knowledge or increased risk perception and behavior (Kieffer et al., 2006; Kim et al., 2007a, b; Smith et al., 2005; Swan et al., 2007; Symons Downs & Ulbrecht, 2006).

The physical activity levels of women with pGDM in the study by Kieffer et al. (2006) did not differ significantly from those of women without pGDM, and almost half
of the total cohort did not meet physical activity guidelines (moderate activity at least 30 minutes per day on 5 days per week or vigorous activity at least 20 minutes per day on 3 days per week). The authors reported that the women with pGDM were no more or less likely to have increased their physical activity than the women without pGDM, despite their elevated risk.

Only 11 of 28 women in one study were meeting current recommendations for physical activity in the postpartum period, whereas only 2 of 28 women believed that exercising postpartum could decrease their risk of future diabetes (Symons Downs & Ulbrecht, 2006). Similarly, only 33.6% of women in another study (N = 226) reported sufficient physical activity, whereas 26.5% were classified as sedentary (Smith et al., 2005). Almost half of the women in this cohort reported not knowing the type of physical activity that would lower their risk for T2DM. Lack of knowledge related to physical activity behaviors was clearly identified among some of the cohorts represented in this review (Smith et al.; Symons Downs & Ulbrecht). Kim et al. (2007b) found that only 31% of women (N = 217) reported meeting current recommendations for vigorous activity 20 minutes three times per week, whereas 22% reported vigorous activity for 20 minutes one to two times per week. Forty-three percent of the women reported light physical activity, and 5% reported no activity at all. Kim et al. (2007a) found no significant associations between recall of provider advice regarding increased physical activity and physical activity behaviors.

Symons Downs and Ulbrecht (2006) and Smith et al. (2005) found that walking was the most popular form of exercise reported during the postpartum period, and sufficient physical activity was significantly associated with high social support and high
self-efficacy for undertaking physical activity (Smith et al.). Swan et al. (2007) found that 31 of 53 women surveyed were classified in the pre-action stage for physical activity, indicating that they were not yet consistently physically active.

**Psychosocial Factors Related to Diet and Physical Activity**

Two of the 8 selected articles specifically discussed psychosocial factors related to postpartum diet and physical activity behaviors of women with pGDM (Smith et al., 2005; Zehle et al., 2008). The Australian study revealed that self-efficacy and social support were positively associated with improved health behaviors; however, self-efficacy and social support were low among the majority of women. Self-efficacy was defined as confidence and skills in cooking healthy foods (Zehle et al.) and confidence to undertake physical activity (Smith et al.). Social support was most often given to women through verbal encouragement but was also related to family food preferences and time constraints surrounding the preparation of healthy foods. Women perceived social support for physical activity behavior when others exercised with them or assisted them with housework and daily activities in order to allow them more time to exercise. However, over half of the women reported never receiving assistance with housework or having others exercise with them (Smith et al.). A busy lifestyle or lack of time were reported by the majority of women as a barrier to healthy eating and physical activity.

**Discussion**

This review revealed common health beliefs and behaviors of women with pGDM, including low perceptions of risk related to the development of diabetes in the future and
suboptimal levels of physical activity and fruit and vegetable intake. Many of the studies reviewed revealed incongruence between risk perceptions or knowledge of prevention strategies and improved lifestyle behaviors related to diet and physical activity, while some studies revealed a lack of knowledge among women with pGDM concerning which lifestyle interventions are necessary to prevent T2DM.

The importance of understanding women’s specific health beliefs and perceptions related to lifestyle modification following GDM cannot be overemphasized. Only when these perceptions and beliefs are taken into account will appropriate intervention strategies be designed and implemented effectively in order to decrease the rates of T2DM among women with pGDM. Women’s health researchers and providers must identify more effective educational interventions to address lack of knowledge related to necessary lifestyle behavioral changes. However, as the majority of studies in this review indicated, many women with pGDM do not lack knowledge; rather, a gap exists between risk perceptions, knowledge, and behavior. Interventions that address other significant contributing factors, such as self-efficacy or perceived advantages and barriers to healthy lifestyle behaviors, may be able to effectively bridge the gap between risk perceptions, knowledge, and necessary health behaviors in this at-risk population. Researchers and clinicians should aim to identify and address these contributing factors in future interventions.

The cross-sectional, retrospective designs and convenience sampling methods in the majority of studies reviewed represent limitations of these studies. Generalizability of the findings is limited because the studies predominantly included non-Hispanic White, socioeconomically advantaged women. This is a notable limitation given that in the U.S.
population, there is an inverse relationship between socioeconomic status (SES) and prevalence of obesity and T2DM (Abate & Chandalia, 2003) and an association between lower SES and the development of GDM (Bo et al., 2002). Lower SES and poorer access to quality health care predispose already at-risk women, such as those with pGDM, to develop T2DM (Black, 2002; Fletcher, Gulanick, & Lamendola, 2002). However, despite the socioeconomic advantages of the majority of women with pGDM represented in this review, the women still reported suboptimal dietary behaviors and levels of physical activity.

It should be noted that 3 articles reviewed represented studies conducted in Australia (Smith et al., 2005; Swan et al., 2007; Zehle et al., 2008), and one study was conducted in Canada (Feig et al., 1998). Maternity policies related to employment may vary among these countries and the United States, potentially affecting women’s actual and perceived behavioral control related to practicing recommended healthy lifestyle behaviors in the postpartum period.

**Implications for Practice and Future Directions**

The majority of studies in this review indicated that women with pGDM did not lack knowledge of the lifestyle changes necessary to prevent T2DM, but some studies showed that women did not recall receiving advice from health care providers concerning preventive lifestyle behaviors (Feig et al., 1998; Symons Downs & Ulbrecht, 2006). Another study revealed that when women did remember providers’ advice, it was not sufficient to produce necessary behavioral change (Kim et al., 2007a). This represents an area requiring attention in research and clinical settings. Women’s health researchers and
providers must identify more appropriate, effective methods to maximize the impact of
counseling to increase self-efficacy to carry out risk reduction behaviors among women
with pGDM.

Modifiable, cognitive, psychosocial factors, including women’s perceived
advantages and barriers and social influences related to dietary and physical activity
behaviors, should inform the development of intervention strategies in this population of
childbearing women with busy lifestyles and competing responsibilities (Smith et al.,
2005; Swan et al., 2007; Zehle et al., 2008). In addition, women’s risk perceptions should
inform the development of preventive intervention strategies (Kim et al., 2007b). Once
sufficient education is provided, additional interventions should focus on increasing
women’s self-efficacy to carry out appropriate risk reduction behaviors in an effort to
address the gap between knowledge and behavior.

Economic implications of implementing prevention strategies in women with
pGDM must be considered; Kieffer et al. (2006) suggested that attention be given to
trends among this population including associated demographic and behavioral correlates
over time in order to design focused, cost-effective interventions. Longitudinal research
would also be useful in examining the associations between women’s intentions to
improve health behavior and actual behavioral change. Similarly, longitudinal research is
necessary to examine whether interventions that successfully modify women’s risk
perception actually improve health behavior and outcomes (Kim et al., 2007b).

Perhaps another area for development is a theoretical framework that more
specifically takes into account the context of the lives of childbearing women, especially
in the postpartum period. Such a framework may explain relationships between risk
factors and lifestyle behaviors and may contribute to the development of effective interventions to reduce cardiometabolic risk.

**Conclusions**

Understanding common risk perceptions, health beliefs, and lifestyle behaviors of women with pGDM may assist women’s health researchers and clinicians in developing appropriate intervention strategies aimed at increasing risk awareness, promoting self-efficacy for healthy lifestyle behaviors, and decreasing rates of cardiometabolic disease among women with pGDM. The future health of women with pGDM depends on the identification and successful implementation of more effective strategies for promoting accurate risk perception, healthy diet, weight control, and adequate physical activity. As women’s health researchers and clinicians, it is our responsibility to realize the significance of a previous diagnosis of GDM on the future cardiometabolic health of women and to devote ample attention and resources to prevention among this population.
References


Table 1: Summary of Articles Included in the Review

<table>
<thead>
<tr>
<th>First Author (Year)</th>
<th>Focal Area</th>
<th>Theoretical / Conceptual Framework</th>
<th>Data Collection Method</th>
<th>Sample Population and Demographics</th>
<th>Location and Basic Inclusion Criteria</th>
<th>Major Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zehle (2008)</td>
<td>Psycho-social factors and postpartum diet behaviors among women with pGDM*</td>
<td>Telephone survey</td>
<td>N = 226 (random), mean age = 33.2±5.3 years, 38.5% spoke a language other than English at home, 34% had attained a college-level education, 49.2% were employed, mean BMI** = 31.87 kg/m²</td>
<td>Sydney, Australia - included women who had attended outpatient diabetes clinics in 1 of 4 hospitals in western Sydney in the past 6-24 months for treatment of GDM</td>
<td>Many dietary risk factors exist among women with pGDM; modifiable cognitive and psychosocial factors influence eating habits</td>
<td></td>
</tr>
<tr>
<td>Kim (2007a)</td>
<td>Preventive counseling and postpartum health and screening behaviors among women with pGDM</td>
<td>Telephone interviews and self-completed questionnaire</td>
<td>N = 228 (convenience), mean age = 36±5.4 years, 71% non-Hispanic white, college educated and affluent, mean BMI = 30.3±7.7 kg/m²</td>
<td>Ann Arbor, Michigan - included women with GDM within the past 5 years and enrolled in a university-affiliated managed care plan</td>
<td>No significant association was found between recall of advice from providers and preventive health behaviors</td>
<td></td>
</tr>
<tr>
<td>Kim (2007b)</td>
<td>Risk perception for T2DM*** and health behaviors among women with pGDM</td>
<td>Telephone interviews and self-completed questionnaire</td>
<td>N = 217 (convenience), mean age = 35.7±5.4 years, 71% non-Hispanic white, college educated and affluent, mean BMI = 30.1±7.7 kg/m²</td>
<td>Ann Arbor, Michigan - included women with GDM within past 5 years and enrolled in a university-affiliated managed care plan</td>
<td>While 90% of women recognized GDM as a risk factor for future T2DM, only 16% believed they had a personal high chance of developing T2DM; plans to modify lifestyle behaviors were more common among women who perceived themselves to be at moderate/high risk</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Risk perception for T2DM and health behaviors among women with pGDM</td>
<td>Theory of Planned Behavior</td>
<td>Self-completed questionnaire returned by mail</td>
<td>N = 53 (convenience), mean age = 32.5±5.1 years, predominantly non-Hispanic white, rural Australian women, BMI 25-29 kg/m² in 24% of cohort and ≥ 30 kg/m² in 42% of cohort.</td>
<td>Victoria, Australia – included women who had attended a regional diabetes center in the past 14 months for treatment of GDM</td>
<td>Despite a high awareness of diabetes prevention strategies, 43% of the participants were not engaged in any diabetes risk reduction behavior</td>
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<td>Swan (2007)</td>
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<td>Kieffer (2006)</td>
<td>Health behaviors among women with and without pGDM</td>
<td>Telephone survey</td>
<td>N = 177,420 total, N = 4,718 women with pGDM (random), mean age of women with pGDM = 33.2 years, 57.7% non-Hispanic white, mean BMI of women with pGDM = 27.4 kg/m²</td>
<td>United States – included women aged 18-44 with and without self-reported pGDM; used the 2001-2003 Behavioral Risk Factor Surveillance System</td>
<td>Women with pGDM reported low levels of physical activity and fruit and vegetable consumption, and nearly ¼ were current smokers; women with pGDM reported worse self-rated health than women without pGDM</td>
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<td>Symons-Downs (2006)</td>
<td>Exercise beliefs and behaviors in women with pGDM</td>
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<td>N = 28 (convenience), mean age = 32 years, 92% non-Hispanic white, 73% at least college educated, 77% with an annual family income of at least $40,000, mean BMI = 32 kg/m²</td>
<td>University Park, Pennsylvania – included women with pGDM within 6 months postpartum</td>
<td>Controlling weight was the strongest perceived advantage of exercise and lack of time was the most common barrier to exercise in the postpartum period; prevalence of exercise behaviors was associated with a greater number of exercise advantages</td>
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<td>Smith (2005)</td>
<td>Psychosocial factors and physical activity behaviors among women with pGDM</td>
<td>Telephone survey</td>
<td>N = 226 (random), mean age = 33.4±5.2 years, 38.5% spoke a language other than English at home, 35.4% had attained a college-level education, BMI 25-29kg/m² in 22.2% of cohort and ≥ 30 kg/m² in 29.1% of cohort</td>
<td>Sydney, Australia – included women who had attended outpatient diabetes clinics in 1 of 4 hospitals in western Sydney in the past 6-24 months for treatment of GDM</td>
<td>Most common barriers to physical activity were lack of child care and lack of time; sufficient physical activity was associated with high social support and high self-efficacy</td>
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<td>Feig (1998)</td>
<td>Self-perceived health status of women with and without pGDM</td>
<td>Self-completed questionnaire returned by mail</td>
<td>N = 262 total, N = 65 women with pGDM, N = 197 controls (convenience), mean age of women with pGDM = 37.97±3.99 years, 46.2% non-Hispanic white, 42.2% with a college-level education, 58.8% employed, mean BMI = 25.25±5.306 kg/m²</td>
<td>Toronto, Ontario – included women with and without pGDM who had participated in a large cohort study 3-5 yrs earlier</td>
<td>Women with pGDM were more worried about their own health, rated their children as less healthy, and perceived themselves as more likely to have diabetes; however, increased worry did not lead to significant changes in preventive health behaviors</td>
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*pGDM = previous gestational diabetes mellitus

**BMI (body mass index) 25-29.9kg/m² is classified as overweight; BMI > 30kg/m² is classified as obese

***T2DM = type 2 diabetes mellitus
Table 2: Recommendations/Guidelines for Women with Previous Gestational Diabetes

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<tr>
<td>Blood glucose should be monitored for 6-8 weeks postpartum until:</td>
<td>• Maintain adequate fiber intake (14 g fiber / 1000 kcal)</td>
<td>• Moderate aerobic activity 150 minutes per week (or 30 minutes per day for 5 out of 7 days)</td>
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<td>• Fasting blood glucose levels are consistently &lt;100 mg/dL and/or</td>
<td>• Reduce saturated fat intake to &lt;7% of total calories</td>
<td>• Resistance training 3 times per week in the absence of contraindications</td>
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<tr>
<td>• 1 hour postprandial levels are consistently &lt;140 mg/dL.</td>
<td>• Limit foods with trans fat</td>
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<td>The ADA (2009) recommends screening this population with:</td>
<td>• Limit alcohol to one drink or less per day</td>
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<tr>
<td>• Fasting blood glucose (FBG) or</td>
<td>• At least 130 g/day of digestible carbohydrates</td>
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<tr>
<td>• 2 hr. oral glucose tolerance test (OGTT)</td>
<td>[eqn]</td>
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If results are normal, the ADA suggests re-screening at least every 3 years.

If BMI is >25 m², a modest weight loss of 7% of total body weight is recommended.

If BMI is <25 m², the goal is weight gain prevention.

Unger (2007) suggests screening this population annually with a 2-hour OGTT.

Individual medical nutrition therapy emphasizing healthy food choices for women with pGDM is advised.

*Individual nutritional needs should be considered. For example, lactating women will have additional nutritional requirements.

Note. BMI = body mass index; pGDM = previous gestational diabetes mellitus; OGTT = oral glucose tolerance test.

A MIXED METHODS INVESTIGATION OF CARDIOMETABOLIC RISK
AND RISK PERCEPTION AMONG OKLAHOMA AMERICAN INDIAN WOMEN
WITH PREVIOUS GESTATIONAL DIABETES

by

EMILY J. JONES, SUSAN J. APPEL, YVONNE D. EAVES, LINDA MONEYHAM,
ROBERT OSTER, AND FERNANDO OVALLE

In preparation for Journal of Mixed Methods Research

Format adapted for dissertation
ABSTRACT

Introduction: Following a diagnosis of gestational diabetes mellitus (GDM), American Indian women are at increased risk for developing type 2 diabetes mellitus (T2DM) and cardiovascular disease (CVD) in comparison to other ethnic groups. Previous studies have shown that women with previous GDM (pGDM) often do not perceive themselves to be at increased risk, or, if they do, they do not possess the self-efficacy to carry out lifestyle behaviors to reduce that risk. There is little reported research concerning the cardiometabolic risk of American Indian women of childbearing age. Furthermore, no research was found that examined the knowledge, risk perceptions, and self-efficacy to prevent future T2DM and CVD among American Indian women with pGDM.

Study Purpose: The purpose of this pilot study was three-fold: 1) To estimate cardiometabolic risk among a sample of Oklahoma American Indian childbearing women; 2) To explore and describe women’s knowledge, perceptions of cardiometabolic risk, and self-efficacy beliefs related to preventing cardiometabolic disease; and 3) To examine relationships among knowledge, risk perceptions, efficacy beliefs, and actual risk.

Methods: A convenience sample of American Indian women with pGDM ages 23-45 (N = 22) was recruited from a tribal health system located in South-central Oklahoma. A descriptive, correlational design with a mixed methodological approach was utilized to address the study aims. We employed qualitative descriptive inquiry using content
analysis in order to analyze qualitative data. Statistical analyses included descriptive analyses, correlational analyses, and regression analyses.

Major Findings: The majority of American Indian women with pGDM in the sample (61.9%) were classified as having metabolic syndrome according to updated guidelines. In addition, 13 of 18 (72.2%) women were identified as being insulin resistant. In general, American Indian women with pGDM had high levels of knowledge related to T2DM and CVD, high risk perception, and low self-efficacy related to preventing cardiometabolic disease. Four major categories and one overarching theme emerged from the qualitative data. The theme, lack of motivation and trying to become motivated, encompassed the categories of concerns, control, beliefs/attitudes, and prevention.

Conclusions: Women’s self-efficacy to prevent cardiometabolic disease is a key factor as we aim to decrease rates of T2DM and CVD in American Indian women with pGDM. This study revealed that high risk perceptions and high levels of knowledge do not necessarily lead to lifestyle behavioral change or increased self-efficacy to prevent cardiometabolic disease among American Indian women with pGDM. Findings from this pilot study indicate the need to further address the element of self-efficacy as we design and implement interventions to decrease cardiometabolic risk in this population. Future research should explore the relationship between depression and self-efficacy related to preventive lifestyle behaviors in American Indian women with pGDM. Interventions to reduce risk should take into account an understanding of how traditional American Indian culture influences women’s health behaviors.
INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of death among American Indian women, as well as a major cause of disability (Indian Health Services [IHS], 2004). The incidence of CVD in American Indians is two times higher than the rates of the general United States (US) population (Howard et al., 1999). Rates of CVD are attributed in part to the increasing rates of type 2 diabetes mellitus (T2DM) in this population (Howard et al.) During 1994 to 2002, the overall age-adjusted prevalence of diabetes for American Indians was more than twice that of US adults overall (Acton, Burrows, Geiss & Thompson, 2003). During this time, prevalence of diabetes was greater among females than males in all age groups. In addition, American Indian females aged 25-34 years had the greatest annual percentage change of diagnosed diabetes (9.1%) among all age groups (Acton, Burrows, Wang & Geiss, 2006). There is a distinct need to identify effective ways to decrease rates of CVD and T2DM among American Indian women.

BACKGROUND

Gestational Diabetes

Gestational diabetes mellitus (GDM), a form of glucose intolerance diagnosed during pregnancy, affects over 200,000 women each year in the United States (U.S.), or about 7% of all pregnant women (American Diabetes Association [ADA], 2004). Women with previous GDM (pGDM) have a 20 to 50 percent chance of developing
T2DM in the next 5 to 10 years (ADA); National Institute of Diabetes and Digestive and Kidney Diseases [NIDDKD], 2005). A systematic review of the literature showed that the cumulative incidence of T2DM among women with pGDM ranged from 2.6 percent to 70 percent in studies that examined women 6 weeks postpartum to 28 years postpartum. According to this review, incidence of T2DM was highest among minority populations including American Indian women with pGDM (Kim, Newton, & Knopp, 2002). In addition to the risk of developing T2DM, women with pGDM are at increased risk for developing CVD, independent of a diagnosis of T2DM (Bentley-Lewis, 2009; King, Gerich, Guzick, King, & McDermott, 2009; Shaw, Retnakaran, & Booth, 2008). Several factors are considered responsible for promoting CVD in women with pGDM including T2DM, hypertension, inflammation, endothelial dysfunction, and dyslipidemia (Bentley-Lewis; King et al.).

**Metabolic Syndrome**

Metabolic syndrome has been defined as a cluster of risk factors including central obesity, dyslipidemia, glucose intolerance, and hypertension that occur together more often than by chance alone (Alberti et al., 2009; Bentley-Lewis, Koruda, & Seely, 2007; National Cholesterol Education Program [NCEP], 2001). The aggregation of these factors into a single entity provides a way to identify individuals at increased risk for the future development of T2DM and CVD (Alberti et al.; NCEP). While there have been many disagreements in the past related to diagnostic criteria for the metabolic syndrome, last year, several major organizations issued a statement in attempt to harmonize the diagnostic criteria (Alberti et al.). These new guidelines suggest that abdominal or
central obesity is no longer an obligatory component of the syndrome, but continues to be a useful preliminary screening tool. Three abnormal findings out of the following five components qualifies a person for the metabolic syndrome: elevated waist circumference (population and country specific definitions [≥ 88 cm in females in the US]), elevated triglycerides (≥ 150 mg/dL), reduced high density lipoprotein cholesterol (HDL-C) (< 50 mg/dL in females), elevated blood pressure (systolic ≥ 130 and/or diastolic ≥ 85 mm Hg), and elevated fasting glucose (≥ 100 mg/dL). Alternatively, drug treatment for elevated triglycerides, HDL-C, blood pressure, and fasting glucose serve as alternate indicators of the components. A single set of cut points have been recommended for all components except waist circumference. At this time, it is recommended that national or regional cut points for waist circumference be used (Alberti et al.).

**American Indians and Metabolic Syndrome**

Using data from the Education and Research Towards Health (EARTH) Study, a large epidemiological study that has been collecting data related to risk factors for chronic diseases among American Indian and Alaska Native people since 2004, the prevalence of metabolic syndrome was estimated to be 43.2% among American Indian men from the Southwestern United States and 47.3% among American Indian women in this region (Schumacher et al., 2008). In comparison, prevalence rates of metabolic syndrome were estimated to be 25.7% among African American women and 35.6% among Mexican-American women using data from the 1988-1994 National Health and Nutrition Examination Survey (NHANES) and age-adjusted to the US 2000 population (Ford, Giles, & Dietz, 2002). Data from the EARTH Study revealed that, among
American Indian women, the most common component of the metabolic syndrome was high waist circumference. Among American Indian participants with metabolic syndrome, 26% had self-reported diabetes. This study also revealed that metabolic syndrome was more common among American Indians than their Alaska Native counterparts (Schumacher et al.). Identifying metabolic syndrome in American Indian women and treating the factors that comprise it may decrease rates of T2DM and CVD in this high-risk population.

**Gestational Diabetes and Metabolic Syndrome**

GDM is considered a unique metabolic syndrome risk factor in women (Bentley-Lewis, Koruda, & Seely, 2007; Retnakaran et al., 2010). Several studies have reported high rates of metabolic syndrome and insulin resistance syndrome (with the additional component of hyperinsulinemia) in women with pGDM (Bo et al., 2006; Lauenborg et al., 2005; Verma, Boney, Tucker, & Vohr, 2002; Vohr & Boney, 2008). A recent study reports that GDM predicts an increased likelihood of metabolic syndrome at 3 months postpartum and women with GDM may have an underlying metabolic syndrome, indicating the need for early cardiovascular risk factor surveillance in this population of childbearing women (Retnakaran et al.). To our knowledge, no research has been conducted to examine the prevalence of metabolic syndrome among childbearing American Indian women with pGDM.
THEORETICAL FRAMEWORK

The Suggested Insulin Resistance Pathway

The metabolic abnormalities that accompany GDM place women at high risk for T2DM and CVD (Bentley-Lewis, 2009; Fonseca, 2003). The conceptual framework for the suggested insulin resistance pathway that displays the progression from normal glucose tolerance to GDM, T2DM, and potential cardiovascular complications by Ben-Haroush, Yogev, and Hod (2004) is a useful physiological model in this pilot study (see Figure 1). Insulin resistance is a normal physiological response during pregnancy, a carbohydrate-intolerant state; in the majority of pregnancies, the demand for more insulin is readily met. However, high-risk ethnic groups such as American Indian women are predisposed to dominant insulin resistance in pregnancy, leading to GDM (Ben-Haroush et al.). Research shows that conditions associated with insulin resistance, such as GDM, may predispose women to hypertension, hyperlipidemia, high levels of plasminogen activator inhibitor-1, leptin, and tumor necrosis factor-alpha. These conditions are associated with increased risk of CVD (Solomon & Seely, 2001). Following pregnancy, many American Indian women with pGDM will develop impaired glucose tolerance that will ultimately lead to the development of T2DM and, potentially, to CVD. As the model indicates, increasing insulin resistance, obesity, age, and parity increase women’s risk for developing GDM, T2DM, and CVD. Improved diet, increased physical activity, and appropriate pharmacological therapy may lead to increased insulin sensitivity and decreased risk for cardiometabolic disease in American Indian childbearing women (Ben-Haroush et al.).
Figure 1 – The Suggested Insulin Resistance Pathway (Ben-Haroush et al., 2004)

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**The Risk Perception Attitude Framework**

A second conceptual framework that complements the physiological model described above is the Risk Perception Attitude (RPA) framework (Rimal & Real, 2003). Even if women have knowledge of the risk that pGDM confers on their future cardiometabolic health, there is little evidence in the literature to support that knowledge alone will lead to self-protective health behaviors. The RPA framework attempts to address the gap that exists between risk perception and self-protective health behavior among individuals who possess knowledge of health risk. Derived from the predictions of the Extended Parallel Process Model (EPPM) (Witte, 1992, 1994) and social cognitive theory (Bandura, 1986), the RPA framework suggests that the construct of self-efficacy plays a mediating role in closing this knowledge-behavior gap. The framework suggests
that perceived risk acts as the motivator and efficacy beliefs act as facilitators to jointly affect subsequent health behavior (Rimal, 2000; Rimal & Real).

According to the insulin resistance pathway model described above, American Indian women with histories of GDM are at increased risk for developing T2DM and CVD. According to the RPA framework, if women possess knowledge of the risk conferred by GDM and have increased risk perception and high efficacy beliefs related to their ability to prevent cardiometabolic disease, they will be more likely to implement lifestyle behaviors that decrease their risk. These models combine to provide an appropriate framework for examining the CMR perceptions and efficacy beliefs of American Indian women with pGDM.

**CONTEXT**

We conducted this descriptive pilot study through a large tribal health care system in South-central Oklahoma. The Institutional Review Board (IRB) of the tribal health care system and the University of Alabama at Birmingham IRB reviewed and approved the research protocol in the fall of 2009.

In 2007, this tribal health system provided more than 350,000 patient visits to more than 40,000 American Indians living in South-central Oklahoma. Since opening in 2004, the Diabetes Care Center of this health system has provided medical, educational, nutritional, and exercise services to American Indians who obtain their healthcare through Indian Health Services. Women who are diagnosed with GDM are referred to the Diabetes Care Center for management during pregnancy and follow-up screening for T2DM at six weeks postpartum.
PURPOSE

The purpose of this pilot study was to estimate cardiometabolic risk among a sample of Oklahoma American Indian childbearing women and to explore women’s knowledge, perceptions of cardiometabolic risk, and self-efficacy beliefs related to preventing cardiometabolic disease using a mixed methods design. Further, we sought to describe relationships among knowledge, risk perceptions, efficacy beliefs, and actual risk. In the first phase, we collected biophysiologic data in order to estimate cardiometabolic risk in the sample. In addition, quantitative questions addressed knowledge of diabetes and cardiovascular risk factors, risk perception for T2DM and CVD, and perceived personal control and optimistic bias related to developing diabetes (measures related to self-efficacy). In the second qualitative phase, interviews were used to probe significant themes related to knowledge, risk perceptions, and self-efficacy beliefs. The reason for following up with the qualitative phase was to better understand and explain the quantitative findings.

RESEARCH QUESTIONS

To our knowledge, this pilot study is the first to explore the cardiometabolic knowledge, risk perceptions, and self-efficacy beliefs of American Indian women with pGDM while estimating women’s cardiometabolic risk. A mixed methods research design allowed us to develop a deeper understanding of American Indian women’s knowledge, risk perceptions, and self-efficacy beliefs while estimating actual cardiometabolic risk and exploring relationships between these variables. Our exploration was guided by the following research questions:
Quantitative Research Questions

1. Do American Indian women exhibit cardiometabolic risk according to updated metabolic syndrome criteria?

2. What cardiometabolic knowledge, risk perceptions, and self-efficacy beliefs related to preventing cardiometabolic disease do these women possess?

3. Do associations exist among women’s cardiometabolic risk, knowledge, risk perceptions, and/or self-efficacy?

Qualitative Research Questions

1. Does the diagnosis of GDM influence Oklahoma American Indian women’s perceptions for future disease?

2. What other factors influence American Indian women’s risk perceptions?

3. What are the views of American Indian women regarding the association between GDM and T2DM and/or CVD?

4. Do American Indian women possess knowledge regarding cardiometabolic risk factors?

5. What are the self-efficacy beliefs of American Indian women regarding their ability to prevent cardiometabolic disease in the future?

Mixed Methods Question

1. How can the understandings that emerge from the qualitative data be used to provide a deeper understanding of the quantitative findings?
METHODS

This study followed an “Explanatory, Sequential” mixed methods design (Creswell & Plano Clark, 2007). In this approach, one method is prioritized, and the term ‘sequential’ indicates the use of the data, not necessarily the timing of data collection (Morgan, 2009). The purpose of this strategy was to explain the results of the quantitative data with the qualitative data; therefore, the qualitative phase followed the quantitative phase and the two methods were integrated at the interpretive level. A notation of this strategy is depicted as follows:

quan → QUAL

The lower-case letters of ‘quan’ indicate a supporting-role of the quantitative data. In this notation, the quantitative data leads to the prioritized ‘QUAL’ data, indicated by the upper-case letters. The arrow indicates dependency of the data or that the qualitative dataset is building upon the quantitative dataset (Morgan).

General Procedures

We recruited childbearing women within a tribal health system who were between the ages of 19 and 45, self-identified as American Indian and as having been diagnosed with GDM in a previous pregnancy. Women who were currently pregnant or had delivered an infant during the past six weeks were excluded from the study related to the collection of biophysiologic data that can be altered during pregnancy, such as waist circumference. The tribal health system care providers and staff served as intermediaries to recruit participants by distributing fliers that described the research to potential participants. Fliers and business cards with the Principal Investigator’s (PI) contact
information were posted throughout the main hospital and satellite clinics. Those women who were interested in taking part in the research were encouraged to call the PI, toll free, to determine eligibility. We recruited a convenience sample of American Indian women with pGDM \( N = 22 \) from four health system campuses spanning South-central Oklahoma. A total of 28 women called to inquire about the study, but four women declined to participate and two women were currently pregnant. Women with diagnosed T2DM \( n = 3 \) were not excluded from the study. We explored risk perceptions and health beliefs related to preventing CVD with these women, while we explored risk perceptions and health beliefs related to preventing T2DM and CVD among women without T2DM \( n = 19 \). Written informed consent was obtained during the first meeting with the participant. Women received gift cards in the amount of $25 for completing all phases of the study including lab tests, the quantitative surveys, and the qualitative interview. They received $15 gift cards for completing any of the above phases of the study. Health system care providers ordered the study laboratory tests and, when appropriate, followed-up with participants regarding the results.

**Quantitative Procedures**

**Quantitative Measures**

Participants completed a short survey to measure demographic characteristics, personal health history, including history of depression diagnosed by a physician, family health history, and current medications. To our knowledge, no instruments have been created to measure knowledge of cardiometabolic risk factors, risk perceptions for cardiometabolic disease, and/or self-efficacy beliefs related to preventing
cardiometabolic disease specifically among women with pGDM, particularly high-risk American Indian women. There are valid and reliable instruments in the literature that were appropriate for use in this special population; however, these have not been validated in the target population. Unfortunately, the small sample size in the current study prevented us from establishing the validity and reliability of these instruments in our sample of childbearing American Indian women with pGDM.

**Knowledge of cardiometabolic risk factors.** The Risk Perception Survey for Developing Diabetes (RPS-DD) that was used in the Diabetes Prevention Program was used in the current study to measure knowledge of diabetes risk factors (Walker, Fisher, Marrero, & McNabb, 2001). This modified 24-item paper and pencil instrument has an 11-item subscale that measures knowledge of diabetes risk factors and has been adapted and used among women with pGDM (Kim et al., 2007b). On this subscale, participants are asked to think about people in the general public and not about their personal risk for diabetes. They are asked to choose the statement that most closely reflects their view of how each item affects others’ risk for diabetes. An example of an item on this subscale is “Having had diabetes during pregnancy.” The four response options include: “Increases or raises the risk,” “Has no effect on risk,” “Decreases or lowers the risk,” and “Don’t know.” Each correct response is given a score of one (incorrect or “Don’t know” responses are scored zero) and summed for a total of 11 possible points on the subscale. Higher scores reflect greater knowledge of risk factors. Kim et al. report acceptable internal consistency (Cronbach’s alpha = 0.70) for the Knowledge of Diabetes Risk Factors subscale among their sample of 217 women with pGDM. A panel of clinical diabetes experts, risk perception experts, and health psychologists assessed content and
face validity during the survey development phase (Walker et al.; Walker, Mertz, Kalten, & Flynn, 2003).

The Heart Disease Fact Questionnaire (HDFQ), a 25-item pencil and paper questionnaire, was created to measure CVD risk factor knowledge in people with diabetes (Wagner, Lacey, Chyun & Abbott, 2005). However, the first 16 questions are not specific to people with diabetes and were used in this pilot study to assess knowledge of CVD risk factors among American Indian women with pGDM. On this scale, participants are asked to respond “True” or “False” to statements concerning heart disease. An example of an item on this subscale is “A person always knows when they have heart disease.” Each correct response is given a score of one (incorrect responses are given a score of zero) and summed for a total of 16 possible points on the scale. Higher scores reflect greater knowledge related to CVD risk factors. Based on extensive pilot data from 524 participants with diabetes, the instrument showed acceptable internal and face validity and internal consistency (Kuder-Richardson-20 formula = 0.77) (Wagner et al.).

Risk perception. Risk perception for developing T2DM and CVD was measured with the following questions: “What do you think your risk or chance is for developing diabetes [heart disease] over the next 10 years?” Follow-up questions were: “If you don’t change your lifestyle behaviors, such as diet or exercise, what is your risk or chance of getting diabetes [heart disease] over the next 10 years?” Response options include “almost no chance,” “slight chance,” “moderate chance,” or “high chance”.

Self-efficacy. The modified version of the RPS-DD, used by Kim et al. (2007b) among women with pGDM, has a four item subscale that measures women’s perceived
personal control and a two item subscale that measures women’s optimistic bias related to the development of diabetes. Perceived personal control related to risk for disease is conceptually similar to self-efficacy. Examples of statements on this subscale include: “I feel that I have little control over risks to my health” and “I think that my personal efforts will help control my risk of getting diabetes.” To measure optimistic bias, participants were asked to respond to the statements: “Compared to other women my same age, I am less likely than they are to get diabetes” and “Compared to other women my same age, I am less likely than they are to get a serious disease.” Response options include “strongly agree,” “agree,” “disagree,” and “strongly disagree.” Both subscales were graded on a scale of one to four and averaged so that greater scores reflected greater personal control and greater optimistic bias for not developing diabetes (Walker et al., 2001). Kim et al. reported acceptable internal consistency in the Personal Control subscale (Cronbach’s alpha of 0.72) in their sample of 217 women; the internal consistency of this subscale was reported at alpha = 0.68 in the DPP (Walker et al., 2001). Kim et al. also reported acceptable internal consistency in the Optimistic Bias subscale (Cronbach’s alpha = 0.65).

Cardiometabolic risk factors. The PI obtained blood pressure, height, weight, and waist circumference and calculated body mass index (BMI) on all participants. Fasting laboratory values were obtained for glucose, insulin, hemoglobin A1C (A1C), and lipids. Laboratory tests were collected and analyzed in the tribal health system laboratories. Standard anthropometric measurements were taken. The PI measured waist circumference at the top of the iliac crest with the patient wearing lightweight clothing. Height was measured using a standard wall mounted device with the participant in
stocking feet and weight was measured using digital physicians’ scales at the various clinical sites. Blood pressure measurements were taken using regularly calibrated equipment at the health system clinics including a sphygmomanometer and appropriately fitting cuff (covering at least two-thirds of the upper right arm). Measurements were obtained three times and averages for the three systolic and diastolic values were calculated for each participant. Each measurement was taken on the participant’s same arm after she had been seated quietly for five minutes, following AHA standards (Grim, 2003).

We used the homeostatic model assessment of insulin resistance (HOMA-ir) (Matthews et al., 1985) to estimate insulin resistance in the sample (see Figure 2).

Figure 2 – Homeostatic Model of Assessment-Insulin Resistance (HOMA-ir) as a Measure of Insulin Resistance (Matthews et al., 1985)

\[
\text{HOMA-ir} = \frac{[\text{fasting glucose (mmol/L)} \times \text{fasting insulin (µU/mL)}]}{22.5}
\]

HOMA-ir > 2.7 indicates insulin resistance

*To convert glucose from mg/dL to mmol/L, multiply by 0.0551

Statistical Analyses

The first and second quantitative research questions were addressed using descriptive statistics. Frequencies, means, and standard deviations were used to summarize the demographic and clinical characteristics of the sample as well as the knowledge, risk perception, and self-efficacy scores. To address the third quantitative research question, Pearson’s correlation coefficients were used to examine relationships among the continuous physiological variables and knowledge and self-efficacy scores. Spearman’s correlation analyses were used to examine the relationships between
physiological variables and the categorical risk perception (low/high) scores. Fisher’s Exact tests were used to evaluate the association between the presence of metabolic syndrome and insulin resistance (using HOMA-ir scores) and risk perception. Independent $t$-tests were used to determine whether differences existed in knowledge and self-efficacy between women with and without metabolic syndrome and insulin resistance. Differences in knowledge and self-efficacy scores were also compared based on the presence of a family history of CVD and/or diabetes and personal history of depression. In addition, independent $t$-tests were used to determine whether differences existed in knowledge scores between those women who were currently treated with antihypertensive and antidyslipidemic medications and those who were not. Multiple linear regression models were used to model the relationships between knowledge, self-efficacy and physiological variables. Multiple logistic regression models were used to model the relationships between risk perception and physiological variables, including metabolic syndrome (yes [3 or more components] or no) and insulin resistance (yes [HOMA-ir > 2.7] or no). All regression models contained either knowledge, risk perception, or self-efficacy as the dependent variable and one of the variables of interest (such as HOMA-ir, depression or family history) as the independent predictor variable. Age was used as a covariate in all models (see Table 8).

The following physiological variables were logarithmically ($\log_{10}$) transformed so that their distributions would be approximately normal: fasting glucose, fasting insulin, A1C, HDL-C, LDL-C, triglycerides, and HOMA-ir scores. An observed or measured value was considered an outlier if it was greater than three standard deviations above the mean or less than three standard deviations below the mean. All statistical
analyses were two-tailed and assumed a significance level of 5%. We used Predictive Analytics SoftWare (PASW) Statistics 18.0 to complete the statistical analysis.

**Qualitative Procedures**

**Qualitative Data Collection**

The PI conducted individual, semi-structured interviews with participants ($n = 17$), aged 23-45 years, in order to elicit qualitative data concerning the knowledge, cardiometabolic risk perceptions, and self-efficacy beliefs of these women related to preventing T2DM and CVD. The interview questions were designed to serve as a follow-up to the quantitative survey questions in order to allow participants to fully describe their perceptions, thoughts, and beliefs. Of those interviewed, three women had been diagnosed with T2DM in the past two months to 15 years, but had no diagnoses of CVD, and 14 of the women were not diagnosed with either T2DM or CVD. The PI conducted interviews until saturation was attained, that is, until no new information surfaced in the interviews. Saturation was attained after interviewing 17 women in the sample. Interviews were audio-recorded and the recordings were downloaded into password-protected files and were transcribed verbatim, omitting identifying information.

**Qualitative Data Analysis**

We used qualitative descriptive inquiry to explore the knowledge, risk perceptions, and self-efficacy beliefs of American Indian women with pGDM and to provide a straightforward description of the phenomenon. Qualitative description aims to provide a comprehensive summary of events in simple, everyday terms. We used content
analysis, the preferred method of analysis in qualitative descriptive studies, to analyze and interpret the qualitative data (Sandelowski, 2000). We modified the content analysis protocol of Graneheim & Lundman (2004) in order to summarize the content of data and identify codes, sub-categories, categories, and an overarching theme.

**Content analysis protocol.** We considered the individual interviews to be the unit of analysis, or the object of our study in the qualitative analysis. We examined the entire text of each of the first four interviews and divided the text into meaning units, that is, words or sentences containing aspects related to each other through their content and context (Graneheim & Lundman, 2004). We then condensed the meaning units and abstracted these condensed meaning units into codes (see Figure 3). We took an exhaustive list of codes from those interviews and condensed them into a more limited list of clusters. From this list, we compared clusters based on similarities and differences and sorted them into categories, or groups of content that shared common meanings (Krippendorff, 1980). This process produced 10 initial categories. We examined the remaining transcripts and labeled data according to their fit in the 10 categories and simultaneously determined whether any of the additional data warranted the creation of new codes or categories. No new codes were present that did not fit well within one of the 10 categories. We further condensed the categories and sorted sub-categories based on similarities and differences of codes. This process produced four major categories. Finally, we interpreted the underlying meaning, or latent content, of the categories into one overarching theme (Graneheim & Lundman) (see Figure 4). Two authors independently coded the data and met to validate the coding scheme and resolve discrepancies in the formulation of sub-categories, categories and the overarching theme.
### Figure 3 – Examples of Meaning Units, Condensed Meaning Units, and Codes

<table>
<thead>
<tr>
<th>Meaning Unit</th>
<th>Condensed Meaning Unit</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutting back on sweets, switching again the diet</td>
<td>Adjusting the diet</td>
<td>Controlling diet</td>
</tr>
<tr>
<td>Kids need to eat better as children and set up their body metabolism better than they do</td>
<td>Begin prevention efforts in children</td>
<td>Start prevention young</td>
</tr>
<tr>
<td>It’s really important to have a good attitude about it, because it’s too easy to talk yourself out of everything if you don’t</td>
<td>Attitude is key in preventing T2D and CVD</td>
<td>Attitude</td>
</tr>
</tbody>
</table>

### Figure 4 – Examples of Codes, Sub-categories, Categories, and Theme

<table>
<thead>
<tr>
<th>Theme</th>
<th>LACK OF MOTIVATION AND TRYING TO BECOME MOTIVATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>CONCERNS</td>
</tr>
<tr>
<td>Sub-category</td>
<td>Risk Conceptions</td>
</tr>
<tr>
<td>Chance to develop illness</td>
<td>Perceived risk related to:</td>
</tr>
<tr>
<td>More likely to get disease</td>
<td>Gaining weight</td>
</tr>
<tr>
<td>Susceptible</td>
<td>Central obesity</td>
</tr>
<tr>
<td>Possibility</td>
<td>Current diet</td>
</tr>
<tr>
<td>Dangerous behavior</td>
<td>Inability to lose weight easily</td>
</tr>
<tr>
<td>Trouble</td>
<td>Using food as comfort</td>
</tr>
<tr>
<td>Hurt</td>
<td></td>
</tr>
<tr>
<td>Caution</td>
<td></td>
</tr>
<tr>
<td>Warning sign</td>
<td></td>
</tr>
<tr>
<td>Taking a risk</td>
<td></td>
</tr>
<tr>
<td>Need medicine or monitoring</td>
<td></td>
</tr>
<tr>
<td>Lurking risk</td>
<td></td>
</tr>
</tbody>
</table>
RESULTS

Quantitative Findings

Participant Characteristics

The average age of participants was 36.59 with a standard deviation of 5.84. Sixteen women (72.7%) were married or living with a partner in a marriage-like relationship. In general, the American Indian women with pGDM in this pilot study were well educated and 18 women (81.8%) were currently employed for wages. Among these women, the average length of time since the most recent occurrence of GDM was 7.64 years. Only eight women (36.4%) had been managed with insulin during pregnancy. Six women (27.3%) reported being diagnosed with hypertension during pregnancy and the same number reported a diagnosis of preeclampsia. Demographic and personal characteristics of the sample are described in Table 1.
Table 1 – Participant Characteristics ($N = 22$)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Number</th>
<th>% (or Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average age (years)</td>
<td>36.59</td>
<td>23-45</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>4</td>
<td>18.2</td>
</tr>
<tr>
<td>Married or living with partner in marriage-like</td>
<td>16</td>
<td>72.7</td>
</tr>
<tr>
<td>relationship</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Separated</td>
<td>2</td>
<td>9.1</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school graduate or GED</td>
<td>1</td>
<td>4.5</td>
</tr>
<tr>
<td>Post high school</td>
<td>11</td>
<td>50</td>
</tr>
<tr>
<td>2 year college degree</td>
<td>6</td>
<td>27.3</td>
</tr>
<tr>
<td>4 year college degree</td>
<td>3</td>
<td>13.6</td>
</tr>
<tr>
<td>Post-graduate</td>
<td>1</td>
<td>4.5</td>
</tr>
<tr>
<td>Employment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currently employed for wages</td>
<td>18</td>
<td>81.8</td>
</tr>
<tr>
<td>Out of work/looking for work</td>
<td>1</td>
<td>4.5</td>
</tr>
<tr>
<td>Homemaker</td>
<td>1</td>
<td>4.5</td>
</tr>
<tr>
<td>Student</td>
<td>2</td>
<td>9.1</td>
</tr>
<tr>
<td>Average number of pregnancies (gravida)</td>
<td>2.77</td>
<td>1-8</td>
</tr>
<tr>
<td>Average number of live births (para)</td>
<td>2.14</td>
<td>1-4</td>
</tr>
<tr>
<td>Average age at birth of first child (years)</td>
<td>24.64</td>
<td>15-38</td>
</tr>
<tr>
<td>Average age during pregnancy complicated with</td>
<td>27.41</td>
<td>18-39</td>
</tr>
<tr>
<td>GDM (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of pregnancies with GDM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One</td>
<td>17</td>
<td>77.3</td>
</tr>
<tr>
<td>Two</td>
<td>3</td>
<td>13.6</td>
</tr>
<tr>
<td>Three</td>
<td>2</td>
<td>9.1</td>
</tr>
<tr>
<td>Average number of years since most recent</td>
<td>7.64</td>
<td>1-20</td>
</tr>
<tr>
<td>occurrence of GDM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birth weight of infant in pregnancy with GDM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.0 to 6.9 (pounds)</td>
<td>5</td>
<td>22.7</td>
</tr>
<tr>
<td>7.0 to 8.9 (pounds)</td>
<td>12</td>
<td>54.5</td>
</tr>
<tr>
<td>9.0 to 10.9 (pounds)</td>
<td>5</td>
<td>22.7</td>
</tr>
<tr>
<td>Managed with insulin for GDM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>8</td>
<td>36.4</td>
</tr>
<tr>
<td>No</td>
<td>14</td>
<td>63.6</td>
</tr>
<tr>
<td>Diagnosed with high blood pressure in pregnancy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>6</td>
<td>27.3</td>
</tr>
<tr>
<td>No</td>
<td>16</td>
<td>72.7</td>
</tr>
<tr>
<td>Diagnosed with preeclampsia in pregnancy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>6</td>
<td>27.3</td>
</tr>
<tr>
<td>No</td>
<td>16</td>
<td>72.7</td>
</tr>
<tr>
<td>Method of delivery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaginal</td>
<td>10</td>
<td>45.5</td>
</tr>
<tr>
<td>Cesarean section</td>
<td>9</td>
<td>40.9</td>
</tr>
<tr>
<td>History of both vaginal and cesarean section</td>
<td>3</td>
<td>13.6</td>
</tr>
</tbody>
</table>

Abbreviation: GDM = gestational diabetes mellitus
**Personal health history and current medications.**

Of the seven (31.8%) women who reported a previous diagnosis of hypertension outside of pregnancy, five (22.7%) women reported taking antihypertensive medication. Of the five (22.7%) women who reported a diagnosis of dyslipidemia, three (13.6%) women reported taking one or more antidyslipidemic medications. Of the three participants with T2DM, two women were taking Metformin and one participant was taking insulin, but no oral antihyperglycemic medication. Of the 13 (59.1%) women who reported a previous diagnosis of depression by their primary care provider, only seven (31.8%) women reported currently taking an antidepressant.

Nine (40.9%) women reported smoking in the past 18 months; however, only five (22.7%) women reported current smoking. Of these, two women reported smoking less than 20 cigarettes per day and three women reported smoking 20 or more cigarettes per day.

**Family health history.**

Twelve (54.5%) women reported a first degree relative with myocardial infarction, stroke, or sudden death by 55 years (male) or 65 years (female). Sixteen women (72.7%) reported a first degree relative with diabetes. Nineteen (86.4%) women reported a first degree relative with hypertension, while nine (40.9%) women reported a first-degree relative with dyslipidemia.

**Clinical Characteristics**

Clinical characteristics of the sample are described in Table 2. Waist circumference was used to classify 19 (86.4%) women with central obesity. A total of
three (13.6%) women were overweight and 16 (72.7%) women were obese based on their BMI. Three women (13.6%) who were categorized as normal weight, based on their BMI, also each had waist circumference values < 88 cm. A mean HOMA-ir score of 6.38 indicates that the sample was highly insulin resistant. HOMA-ir identified 13 of 18 (72.2%) women as having insulin resistance.

Updated guidelines (Alberti et al., 2009) classified 13 of 21 (61.9%) women as having metabolic syndrome. Three participants chose to not have study labs drawn. Given that there are alternate indicators of the metabolic syndrome components, including drug treatment for dyslipidemia, hyperglycemia, or hypertension, we were able to identify the metabolic syndrome in two of these three women. However, without appropriate lab values, we were not able to determine presence of metabolic syndrome in the last participant; therefore, metabolic syndrome was estimated in a sample of 21 women. Presence of metabolic syndrome components is described in Table 3.

Table 2 – Clinical Characteristics of the Cohort

<table>
<thead>
<tr>
<th>Variables</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waist circumference, cm</td>
<td>22</td>
<td>111.70</td>
<td>20.48</td>
<td>78.74 – 167.64</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>22</td>
<td>34.39</td>
<td>8.41</td>
<td>21.8 – 56.3</td>
</tr>
<tr>
<td>SBP, mm Hg</td>
<td>22</td>
<td>122.45</td>
<td>15.44</td>
<td>79 – 147</td>
</tr>
<tr>
<td>DBP, mm Hg</td>
<td>22</td>
<td>73.77</td>
<td>9.96</td>
<td>45 – 92</td>
</tr>
<tr>
<td>Fasting glucose, mg/dL&lt;sup&gt;a&lt;/sup&gt;</td>
<td>19&lt;sup&gt;b&lt;/sup&gt;</td>
<td>99.16</td>
<td>13.34</td>
<td>73.0 – 136.0</td>
</tr>
<tr>
<td>Fasting insulin, μU/mL&lt;sup&gt;a&lt;/sup&gt;</td>
<td>19</td>
<td>23.82</td>
<td>18.92</td>
<td>3.8 – 74.1</td>
</tr>
<tr>
<td>HOMA-ir&lt;sup&gt;a&lt;/sup&gt;</td>
<td>18&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.38</td>
<td>5.74</td>
<td>0.78 – 20.98</td>
</tr>
<tr>
<td>A1C&lt;sup&gt;a&lt;/sup&gt;</td>
<td>18&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.67</td>
<td>0.38</td>
<td>5.0 – 6.4</td>
</tr>
<tr>
<td>Triglycerides, mg/dL&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20</td>
<td>118.05</td>
<td>87.56</td>
<td>36 – 338</td>
</tr>
<tr>
<td>HDL-C, mg/dL&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20</td>
<td>49.80</td>
<td>9.09</td>
<td>40 – 68</td>
</tr>
<tr>
<td>LDL-C, mg/dL&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20</td>
<td>112.34</td>
<td>32.53</td>
<td>46 – 180.4</td>
</tr>
</tbody>
</table>

<sup>a</sup> Log-transformed before statistical analysis
<sup>b</sup> One outlier has been removed from the analysis

Abbreviations: BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; HOMA-ir, Homeostatic Model of Assessment-insulin resistance; A1C, Hemoglobin A1C; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol.
Table 3 – Metabolic Syndrome Components (N = 21)

<table>
<thead>
<tr>
<th>Component</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of elevated waist circumference (≥88 cm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>18</td>
<td>85.7</td>
</tr>
<tr>
<td>No</td>
<td>3</td>
<td>14.3</td>
</tr>
<tr>
<td>Presence of elevated triglycerides or drug treatment for elevated triglycerides (&gt;150 mg/dL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>6</td>
<td>28.6</td>
</tr>
<tr>
<td>No</td>
<td>15</td>
<td>71.4</td>
</tr>
<tr>
<td>Presence of low HDL or drug treatment for reduced HDL (&lt;50 mg/dL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>14</td>
<td>66.7</td>
</tr>
<tr>
<td>No</td>
<td>7</td>
<td>33.3</td>
</tr>
<tr>
<td>Presence of elevated systolic or diastolic blood pressure or treatment with antihypertensive (≥130 systolic or ≥85 diastolic)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>11</td>
<td>52.4</td>
</tr>
<tr>
<td>No</td>
<td>10</td>
<td>47.6</td>
</tr>
<tr>
<td>Presence of elevated fasting glucose or drug treatment for elevated fasting glucose (&gt;100 mg/dL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>10</td>
<td>47.6</td>
</tr>
<tr>
<td>No</td>
<td>11</td>
<td>52.4</td>
</tr>
<tr>
<td>Number of metabolic syndrome components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zero</td>
<td>1</td>
<td>4.5</td>
</tr>
<tr>
<td>One</td>
<td>2</td>
<td>9.1</td>
</tr>
<tr>
<td>Two</td>
<td>5</td>
<td>23.8</td>
</tr>
<tr>
<td>Three</td>
<td>7</td>
<td>33.3</td>
</tr>
<tr>
<td>Four</td>
<td>4</td>
<td>19.0</td>
</tr>
<tr>
<td>Five</td>
<td>2</td>
<td>9.5</td>
</tr>
<tr>
<td>Presence of metabolic syndrome (presence of ≥3 components)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>13</td>
<td>61.9</td>
</tr>
<tr>
<td>No</td>
<td>8</td>
<td>38.1</td>
</tr>
</tbody>
</table>

Of note, we calculated Framingham Global Risk Assessment Scores; however, this risk assessment tool was not an appropriate predictor of cardiovascular risk in our sample. According to this tool, 13 (65%) women were classified as having < 1% risk for hard coronary heart disease outcomes in the next 10 years. Of the remaining women, no one had a risk score > 9%. There is evidence that the Framingham Risk Score generally underestimates lifetime CVD risk in younger individuals despite substantial risk factor burden (Lee et al., 2010). There is a need to identify and use appropriate tools to predict cardiovascular risk in childbearing women.
**Cardiometabolic Knowledge, Risk Perception, and Self-Efficacy Beliefs**

The mean Knowledge of Diabetes Risk Factors score was 7.58 out of a possible 11, reflecting that >90% of our sample was aware of the roles of activity, diet, and controlling weight in preventing diabetes and of the increased risk for diabetes among American Indians. All participants were aware of the increased risk for diabetes conferred by GDM. Fewer women were aware of the increased risk for diabetes conferred by race and ethnicity (other than American Indian race) and age.

The mean HDFQ score was 15.09 out of a possible 16, reflecting that >90% of our sample was aware of the roles of activity, diet, cholesterol, and family history related to risk for CVD. Fewer women were aware of the increased risk for CVD conferred by age and specific types of cholesterol (HDL-C and LDL-C). Overall, the HDFQ scores revealed a high level of knowledge among our sample concerning CVD risk factors.

The mean Personal Control score was 3.07 out of a possible 4, indicating a somewhat high degree of perceived personal control for not developing diabetes. The mean Optimistic Bias score was 2.13 out of a possible 4, reflecting lower optimistic bias for not developing diabetes. This score reflects the women’s general belief that they are more likely to develop diabetes compared to other women of the same age. (See Table 4).

<table>
<thead>
<tr>
<th>Table 4 – Cardiometabolic Knowledge and Self-Efficacy Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Personal control related to not developing diabetes</strong></td>
</tr>
<tr>
<td>(scale range 1-4)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Optimistic bias for not developing diabetes</strong></td>
</tr>
<tr>
<td>(scale range 1-4)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Knowledge of Diabetes Risk Factors</strong></td>
</tr>
<tr>
<td>(scale range 0-11)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Knowledge of CVD Risk Factors</strong></td>
</tr>
<tr>
<td>(scale range 0-16)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>n</strong></td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>19</td>
</tr>
<tr>
<td>19</td>
</tr>
<tr>
<td>19</td>
</tr>
<tr>
<td>22</td>
</tr>
</tbody>
</table>
Regarding risk perception, three (15.8%) women believed that they had a slight chance of developing diabetes over the next 10 years, 10 (45.5%) women believed they had a moderate chance of developing diabetes, and six (31.6%) women believed they had a high chance of developing diabetes. When asked about their risk perception if they did not change lifestyle behaviors, the number of women who believed they had a high chance of developing diabetes almost doubled ($n = 11; 57.9\%$). Regarding risk perception related to developing CVD over the next 10 years, one (4.5%) woman reported almost no chance, eight (36.4%) women reported a slight chance, eight (36.4%) women reported a moderate chance, and five (22.7%) women reported a high chance. Again, when asked about their risk perception if they did not improve their current lifestyle, the number of women who believed they had a high chance of developing CVD almost doubled ($n = 9; 40.9\%$). Risk perception scores are described in Table 5.

### Table 5 – Risk Perception Scores

<table>
<thead>
<tr>
<th>Risk perception for developing diabetes over the next 10 years</th>
<th>$n$</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slight</td>
<td>3</td>
<td>15.8</td>
</tr>
<tr>
<td>Moderate</td>
<td>10</td>
<td>45.5</td>
</tr>
<tr>
<td>High</td>
<td>6</td>
<td>31.6</td>
</tr>
<tr>
<td>Risk perception for developing diabetes over the next 10 years if participant does not change her lifestyle behaviors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slight</td>
<td>1</td>
<td>5.3</td>
</tr>
<tr>
<td>Moderate</td>
<td>7</td>
<td>36.8</td>
</tr>
<tr>
<td>High</td>
<td>11</td>
<td>57.9</td>
</tr>
<tr>
<td>Risk perception for developing CVD over the next 10 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Almost no risk</td>
<td>1</td>
<td>4.5</td>
</tr>
<tr>
<td>Slight</td>
<td>8</td>
<td>36.4</td>
</tr>
<tr>
<td>Moderate</td>
<td>8</td>
<td>36.4</td>
</tr>
<tr>
<td>High</td>
<td>5</td>
<td>22.7</td>
</tr>
<tr>
<td>Risk perception for developing CVD over the next 10 years if participant does not change her lifestyle behaviors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slight</td>
<td>5</td>
<td>22.7</td>
</tr>
<tr>
<td>Moderate</td>
<td>8</td>
<td>36.4</td>
</tr>
<tr>
<td>High</td>
<td>9</td>
<td>40.9</td>
</tr>
</tbody>
</table>
Correlation Analyses

Relationships among cardiometabolic risk factors.

Bivariate correlations among cardiometabolic risk factors are presented in Table 6. As we would expect, waist circumference and BMI were significantly positively associated \( (r = .977; p < .000) \). A1C was significantly correlated with BMI \( (r = .499; p = .035) \) and approached significance with waist circumference \( (r = .428; p = .077) \). A1C was also significantly correlated to fasting insulin \( (r = .589; p = .010) \) and HOMA-ir \( (r = .620; p = .006) \), with fasting glucose as a covariate. Fasting insulin was significantly correlated with fasting glucose \( (r = .788; p = .000) \) and with the presence of metabolic syndrome \( (r_s = .662; p = .002) \). A significant positive relationship existed between HOMA-ir and presence of the metabolic syndrome \( (r_s = .711; p = .001) \), with fasting glucose as a covariate. Inverse relationships were found between HOMA-ir and HDL-C \( (r = -.620; p = .006) \) and fasting insulin and HDL-C \( (r = -.592; p = .008) \). Inverse relationships were identified between HDL-C and triglycerides \( (r = -.472; p = .036) \) and LDL-C \( (r = -.508; p = .022) \), and LDL-C was significantly positively correlated to triglycerides \( (r = .608; p = .004) \).
Table 6 – Bivariate Correlations Among Cardiometabolic Risk Factors
(Continued on next page)

<table>
<thead>
<tr>
<th></th>
<th>WC, cm</th>
<th>BMI, kg/m²</th>
<th>SBP, mm Hg</th>
<th>DBP, mm Hg</th>
<th>Fasting glucose mg/dL&lt;sup&gt;a&lt;/sup&gt;</th>
<th>A1C, mg/dL&lt;sup&gt;a&lt;/sup&gt;</th>
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<td></td>
<td>.000</td>
<td>.620</td>
<td>.397</td>
<td>.483</td>
<td>.077</td>
</tr>
<tr>
<td>BMI</td>
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<td>1</td>
<td>.096</td>
<td>.239</td>
<td>.201</td>
<td>.499*</td>
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<td></td>
<td>.000</td>
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<td>.284</td>
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<tr>
<td>SBP</td>
<td>.112</td>
<td>.096</td>
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<td>.756**</td>
<td>.171</td>
<td>.209</td>
</tr>
<tr>
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<td>.000</td>
<td>.484</td>
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<td>1</td>
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<td>.000</td>
<td>.709</td>
<td>.223</td>
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<tr>
<td>Fasting glucose&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>.201</td>
<td>.171</td>
<td>.092</td>
<td>1</td>
<td>.687**</td>
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<td>.410</td>
<td>.484</td>
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<td>.260</td>
<td>.251</td>
<td>.788**</td>
<td>.589*</td>
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<td>.377</td>
<td>.221</td>
<td>.193</td>
<td>.841**</td>
<td>.620**</td>
</tr>
<tr>
<td>TG&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>-.096</td>
<td>.415</td>
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<td>-.284</td>
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<td>-.040</td>
<td>-.334</td>
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<td>LDL-C&lt;sup&gt;a&lt;/sup&gt;</td>
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</tbody>
</table>

<sup>a</sup>Log-transformed before statistical analysis

First row represents correlation; second row represents p-value for that correlation

* p-value < 0.05; ** p-value < 0.01

Abbreviations: WC, waist circumference; BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; A1C, Hemoglobin A1C; HOMA-ir, Homeostatic Model of Assessment-insulin resistance; TG, triglycerides; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; MetS, metabolic syndrome.
Table 6 – Bivariate Correlations Among Cardiometabolic Risk Factors (cont.)

<table>
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<tr>
<th></th>
<th>Fasting insulin, μU/mL</th>
<th>HOMA-ir</th>
<th>TG, mg/dL</th>
<th>HDL-C, mg/dL</th>
<th>LDL-C, mg/dL</th>
<th>MetS yes/no</th>
</tr>
</thead>
<tbody>
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<td>WC</td>
<td>.405</td>
<td>.362</td>
<td>-.116</td>
<td>-.300</td>
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<td>BMI</td>
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<td>Fasting glucose</td>
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<td>.584**</td>
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<td>BMI, body mass index;</td>
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<td>DBP, diastolic blood</td>
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<td>pressure; DBP,</td>
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<td>HDL-C,</td>
<td>low-density lipoprotein</td>
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<td>cholesterol; MetS,</td>
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<tr>
<td>Metabolic</td>
<td>syndrome.</td>
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</table>

*Log-transformed before statistical analysis
First row represents correlation; second row represents p-value for that correlation
* p-value < 0.05; ** p-value < 0.01
Abbreviations: WC, waist circumference; BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; A1C, Hemoglobin A1C; HOMA-ir, Homeostatic Model of Assessment-insulin resistance; TG, triglycerides; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; MetS, metabolic syndrome.

Relationships among cardiometabolic risk factors and knowledge.

Diabetes knowledge was significantly inversely correlated to LDL-C (r = -.496; p = .036). In addition, inverse correlations between diabetes knowledge and fasting glucose (r = -.393; p = .106), fasting insulin (r = -.431; p = .084), and HOMA-ir (r = -.455; p = .067) trended toward significance. In contrast, CVD knowledge was positively
correlated with certain cardiometabolic risk factors including systolic blood pressure ($r = .484; p = .022$) and LDL-C ($r = .511; p = .021$), and positive associations approached significance with diastolic blood pressure, fasting insulin, and HOMA-ir scores. There were no significant differences in diabetes and CVD knowledge scores between women who were currently being treated with antihypertensive and antidyslipidemic medication and those who were not. In addition, there were no statistically significant differences in knowledge scores between women with and without metabolic syndrome and insulin resistance (See Table 7).

Table 7: Diabetes and CVD Knowledge Scores

<table>
<thead>
<tr>
<th></th>
<th>Treatment with Antihypertensive</th>
<th>Treatment with Antidyslipidemic</th>
<th>Metabolic Syndrome</th>
<th>Insulin Resistance</th>
<th>Treatment with Antihypertensive</th>
<th>Treatment with Antidyslipidemic</th>
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</thead>
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<tr>
<td></td>
<td><strong>n</strong></td>
<td><strong>Mean</strong></td>
<td><strong>SD</strong></td>
<td><strong>P</strong></td>
<td><strong>n</strong></td>
<td><strong>Mean</strong></td>
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<tr>
<td><strong>CVD Knowledge</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(scale range 1-16)</td>
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<tr>
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<td>15.00</td>
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<td>15.00</td>
<td>1.22</td>
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<td>3</td>
<td>15.67</td>
</tr>
</tbody>
</table>
**Relationships among cardiometabolic risk factors and risk perception.**

Risk perception for diabetes was significantly positively correlated with a family history of diabetes ($r_s = .502; p = .029$). A significant positive relationship existed between risk perception for CVD, given no changes in lifestyle behaviors, and current diagnosis of diabetes ($r_s = .436; p = .043$). The positive correlation between current risk perception for CVD and diagnosis of diabetes approached significance ($r_s = .420; p = .052$). No statistically significant associations were identified between risk perceptions for T2DM and CVD and presence of metabolic syndrome, insulin resistance, diagnosed diabetes, depression, or family history of T2DM and CVD.

**Relationships among cardiometabolic risk factors, depression, and self-efficacy beliefs.**

We identified a significant positive relationship between family history of CVD and personal control related to developing diabetes ($r_s = .492; p = .032$). We found a significant difference in means between women with and without family history of CVD on personal control for diabetes ($p = .037$). History of depression was inversely correlated to personal control related to developing diabetes at a level that approached significance ($r_s = -.367; p = .123$). Likewise, history of depression was significantly inversely correlated with optimistic bias related to developing diabetes ($r_s = -.556; p = .013$). There were significant differences in the means between women with and without depression on optimistic bias scores ($p = .018$). Differences between the means of these two groups of women approached significance related to personal control for developing diabetes ($p = .132$). There were no statistically significant differences between women with and without metabolic syndrome or insulin resistance related to personal control or optimistic bias for developing diabetes.
Regression Analyses

The results of the multiple linear regression analyses performed on the major outcome variables including knowledge, personal control, optimistic bias, and HOMA-ir appear in Table 8. Results for models with statistically significant predictors or predictors that display a trend toward significance are displayed. Age was included as a covariate in all models. The best model describing knowledge of diabetes risk factors as an outcome variable appears to include LDL-C (Model $p = .094; p = .034; R^2 = 0.27$). The best model describing CVD risk factor knowledge as an outcome variable seems to include 3 variables: systolic blood pressure, HOMA-ir, and LDL-C (Model $p = .003; R^2 = 0.69$). The best model describing personal control related to developing diabetes as an outcome variable includes family history of CVD (Model $p = .103; p = .037; R^2 = 0.25$). The best model describing optimistic bias related to developing diabetes as an outcome variable includes depression (Model $p = .038; p = .013; R^2 = .34$). The best model describing HOMA-ir as an outcome variable includes metabolic syndrome (yes [3 or more components] or no) (Model $p = .005; p = .002; R^2 = 0.51$). Using multiple logistic regression models, there were no statistically significant predictors for the risk perception outcome variables (low [almost no chance or slight chance] or high [moderate or high chance]).
Table 8 – Multiple Regression Models for Major Outcome Variables

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Independent Variable</th>
<th>P</th>
<th>Model P</th>
<th>Model R²</th>
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<tr>
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<td>Optimistic Bias</td>
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</tr>
<tr>
<td>T2DM</td>
<td>Age</td>
<td>.287</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Log-transformed before statistical analysis
Abbreviations: SBP, systolic blood pressure; HOMA-ir, Homeostatic Model of Assessment-insulin resistance; LDL-C, low-density lipoprotein cholesterol.

Qualitative Findings

From the qualitative data, one major theme and four major categories were identified. The common thread, or theme, we identified throughout all the qualitative data was that women lacked the motivation to change lifestyle behaviors, even though the majority of women reported having knowledge and increased risk perception for these diseases. The overarching theme, which we have termed, ‘lack of motivation and trying
to become motivated’, encompasses the four major categories: (a) concerns, (b) control, (c) beliefs/attitude, and (d) prevention. Each category is discussed in detail in the following sections.

**Concerns**

Participants discussed numerous concerns related to the risk for future T2DM and/or CVD. Four sub-categories emerged from the data including: (a) risk conceptions, (b) risk perceptions, (c) risk factors, and (d) impact on family.

**Risk conceptions.** Women conceptualized risk negatively using words such as ‘danger,’ ‘warning,’ ‘trouble,’ and ‘lurking’ to describe risk. Women also described risk as an increased chance or likelihood, or increased susceptibility, for developing disease.

**Risk perceptions.** Women discussed factors that increased their risk perception for developing T2DM and/or CVD. Perceived risk was often related to the women’s weight. Women frequently referred to gaining weight in recent years, experiencing difficulty losing weight, and the presence of abdominal obesity when discussing concerns related to risks to their health. Family history also appeared to be very important to the participants in a discussion of concerns related to risk for T2DM and CVD. Many women expressed situational risk perception related to family history; that is, if a family member(s) had experienced poor health related to either diabetes or CVD, the women believed that they, too, were at increased risk for developing the disease. On the other hand, women often indicated low risk perception for CVD when they did not have a family history. This concept of situational risk perception is well illustrated in the words of one participant:
The cholesterol is the thing, you know, I need to change. But, there is no heart disease at all in my family, so I don’t think that way. I don’t think in that perspective. I think about the diabetes more than heart disease.

**Risk factors.** Participants identified numerous risk factors for T2DM and CVD. Among those most frequently mentioned were weight gain, being American Indian, family history, genetics, having pGDM, age, decreased physical activity, consuming a diet high in fat and carbohydrates, stress, smoking, and a current diagnosis of T2DM. One participant described her increased risk perception for diabetes related to being American Indian:

> You know when you grow up and you just hear about those things, you know, “Indians get diabetes;” well, I mean, just like African Americans get, what is it, sickle cell? It’s just associated with the race and that’s what I’ve been [told], it’s been pounded into my head growing up.

Another participant described her increased risk perception for CVD related to genetics and family history:

> Sometimes I kind of think I might have a higher chance, only because of my mother. My mother started having [heart problems], her father actually died at the age of 42 with a massive heart attack and he had a brother that died. I think he had a massive heart attack when he was in his early 50s. So, they were still pretty young. My mother has just turned 60, but she’s had heart problems for the past 10 years. And so I really think that genetics is a major factor, only seeing her father, now she’s got it, and I kind of wonder. And I’ve had a heart murmur, they
found a heart murmur years ago. I always think that my chances are high just because of genetics.

**Impact on family.** A major concern of participants was how their health impacted the rest of their family. Many women expressed the desire to “be around” for their children and grandchildren in discussions of risk for T2DM and CVD. One participant described the exhaustion she experiences at times when playing with her toddler son:

And, more than anything, I want to be healthy because I want to play with him and not be tired all the time. You know, not just for me, but for him. Because my partner and I talk about wanting more kids, and I can’t imagine, if I got pregnant now, how much bigger I would be after the second pregnancy and how much more tired I would be. I want to be healthy for my family.

Several women expressed worry regarding their children’s health related to family history, weight gain, lack of physical activity, and the family’s traditional high fat, high carbohydrate diet. One participant expressed concern that she was not a very good role model for her children related to diet:

I don’t like broccoli in so many ways, and it’s like my husband says, “You have to eat your broccoli” and I’m like the kid going, “Do I have to?” And my daughter, “Yes, if I have to eat this stuff, you are too.” So, it’s kind of really…I’m not a very good role model. I’ll eat salads and what have you and I’ll eat broccoli salad – raw broccoli salad, but, if you’ve ever noticed, it has bacon and mayonnaise in it!

Many of the participants discussed concerns related to the family diet. Participants expressed frustration related to the fact that family members do not prefer to
eat healthy foods such as fruits and vegetables. Because their spouses and children have often not appreciated healthy cooking in the past, the participants expressed an unwillingness or lack of motivation to prepare healthy meals. One participant described her concern this way:

And, then, he’s [her partner] very much – if he could have chicken fried steak and mashed potatoes everyday – that’s what he would eat. And, so, if I could get him – I don’t want to make food just for me at the table. If I could instill healthy eating with the whole family, but he’s so picky. And so I let that affect me a lot because I just don’t want to make something if he’s going to go, “Ooh, I don’t want to eat that.”

**Control**

Participants repeatedly referred to perceived control related to the risk for T2DM and CVD. In this category of control, two sub-categories emerged from the data including (a) changing behaviors and (b) influence of culture. Women discussed lifestyle behaviors they could control; however, in these discussions, women often spoke of traditional American Indian culture and how living within this culture often makes controlling lifestyle behaviors very challenging.

**Changing behaviors.** Participants frequently discussed lifestyle behaviors that they felt they could control, or, more often, try to control. This language of ‘trying’ was very common among participants as they discussed the need to make behavioral changes in order to decrease their risk for T2DM and CVD. For example, one participant stated she had “tried to watch the foods I eat” and “tried to alter the way I cook.” Another
stated, “I’ve almost banned the cookies, but my kids have to have cookies once in a while and I see myself eat one, but I try to limit myself to one and not half the package.”

Frequently, participants referred to their attempt to control diet and exercise. Most times, these behavioral changes were connected to the women’s attempts to lose weight. Several participants discussed recently beginning new diets at the recommendation of their health care providers. Most often, these included appetite suppressants and plans for increased physical activity. Some of the participants also noted that taking blood pressure medication as prescribed was a way they could control risks to their health.

Many women noted the need to learn new recipes or new ways of cooking that differed from the traditional American Indian patterns of cooking. Many participants spoke of specific dietary changes they had either recently begun to incorporate or saw the need to incorporate into the family diet including baking rather than frying, consuming more fruits and vegetables, consuming whole wheat bread rather than white bread, and consuming less soda pop. One participant described her recent realization of the need to make behavioral changes: “I’m making the transition now. I’m noticing and seeing, or I guess I just had the ‘Aha’ moment, where I’m not young anymore…that’s rough!”

Participants frequently noted the difficulty they encountered when attempting to incorporate lifestyle behavioral changes into their daily lives. One participant expressed it this way: “Trying to actually practice it in my home, yeah, it’s somewhat difficult, you know, because we’re all used to this lifestyle. And it’s a major change.” Commonly, participants would note that there are factors, such as family history or genetic risk, outside of their control. One participant with T2DM noted:
Well, keeping the weight down, watching the blood sugars, that would be control. [There is] not a whole lot of control with family history, so you’ve just got to make sure you maintain those things and hopefully you’ll have a little bit more control than the inevitable.

**Influence of culture.** Many participants discussed the impact of American Indian culture on their lifestyle behaviors. The importance of food in social settings was considered to be a barrier to controlling diet. One woman described it in this way: “. . .everything revolves around food and, a lot of native peoples, that’s their highlight of any kind of social gathering is that you’ve got to have food to celebrate.” Women talked about the high fat, high sodium, high carbohydrate foods that are common to the present day American Indian diet. When probed to further describe her control related to “learning to cook right,” a participant with T2DM commented: “Not cooking like most or all Indians do; we fry everything – deep fry everything. Fry bread, fried potatoes, and we love it. That’s what was our meal; that’s what we was raised up on.” One participant described:

I was raised in a traditional Native American family and more traditional people do use a lot of high fat, high sugary foods; a lot of our traditional food is based on that. And, so, as to someone that maybe wasn’t traditional, they would probably be more prone to having other foods that, I don’t know, just say lots more light cooking. And I try to do that myself, but the thing is, we focus a lot of our meals as social gatherings, so in order to have a social gathering, you have all these traditional, or high fat, greasy foods and of course that’s just when you think, “Oh!” and you just pig out. And, the more events, the more family functions we
have, the more eating we do, and I have no self-control. When I’m at home with my family, I do better, but whenever we’re with our [extended] family, that’s the first thing we do, we’re eating fried potatoes, you know, pork chops, stuff like that.

Another participant expressed the belief that a traditional cultural connection between food and spirituality seemed to be a thing of the past. To her, this change was detrimental to the health of American Indians:

Yeah and also spirituality of what you eat, what you put into your body, all that stuff. It’s all connected and it’s all gone. So, that’s another big part of it. You know, that’s the reason that they blessed the buffalo because it was going to become part of them – the spirit of that animal or whatever animal that they were taking. They realized that what they ate had something to do with who they are. That’s gone. Not gone completely but a lot of it is.

**Beliefs/Attitude**

Participants commonly expressed personal health beliefs and attitudes related to their risk for T2DM and/or CVD. Four distinct sub-categories emerged from the data including (a) knowledge, (b) disease processes, (c) level of confidence, and (d) hope.

**Knowledge.** This sub-category encompasses various aspects of knowledge related to T2DM and CVD, ranging from information received from health care providers to information seeking behaviors to anecdotal knowledge of others’ experiences with these diseases. All participants reported receiving information from their physicians related to
risk for T2DM following a diagnosis of GDM. In addition, participants with T2DM recalled healthcare provider discussions regarding increased risk for CVD.

Women reported information seeking behaviors to increase their knowledge related to GDM, T2DM, and CVD. Many of these reported searching the Internet, books, and popular health magazines for such information. Several participants also discussed recent increased awareness related to women’s risk for CVD. While describing why she felt her own risk for CVD was low, one participant stated: “I don’t know. I think it’s low, but nowadays they’re telling women, ‘Don’t think that way,’ because they’re not putting heart disease in focus like they are in other diseases.”

Participants commonly shared stories about family members or close friends who had been diagnosed with T2DM and/or CVD. The experiences of others clearly impacted women’s personal health beliefs related to T2DM and CVD. For example, in a discussion of why she did not believe T2DM and CVD were related in any way, one participant alluded to her own father’s experience with these diseases:

I think the heart disease is just something separate. I know they say diabetes contributes to heart disease, but I don’t [believe this]. My dad didn’t develop diabetes until after his heart problems. So, I mean, it was kind of like it was an after-thing . . . I think heart disease is something separate; I think they can both affect each other, but I don’t think that if you’ve got diabetes you’re going to have heart disease. I think it’s mainly what you’re eating and your family [history].

**Disease processes.** Participants described various health beliefs related to GDM, T2DM, and CVD. Many women expressed the belief that lifestyle behaviors were
insufficient for prevention, but could be sufficient for prolonging the onset of T2DM and CVD. Other women expressed beliefs that these diseases could not be prevented in all cases, most often related to genetic risk. However, some believed that the majority of cases were preventable if certain lifestyle behaviors were changed and healthier behaviors were adopted. Interestingly, the participants with T2DM each described the belief that CVD is inevitable in individuals with diabetes. One woman expressed: “So, I’m hoping to put it [CVD] off as long as possible. So, I’m not sure. If I get it, I’m not going to be shocked, but if I don’t get it, then I will be shocked!” These women referenced conversations with healthcare providers in which they were informed of increased risk for CVD; however, more commonly, the participants described the experiences of family members who had developed CVD following a diagnosis of diabetes.

Participants frequently postulated relationships between GDM, T2DM, and CVD. Women commonly believed that GDM conferred risk for future T2DM and many thought that it might increase one’s risk for CVD, as well; although, most women reported that they never thought about that connection. When thinking about the connection between GDM and T2DM, one woman stated: “I think once it’s [GDM] there or almost diagnosed as there, then you always carry it with you, but you have to work at it not to have it.” Frequently, participants referred to a ‘circulation link’ between T2DM and CVD; that is, they believed that T2DM conferred risk for CVD related to the effect of high blood sugar in the circulation. One woman clearly described this belief:

Well, I just think that, with diabetes, I think there are other things going on in your body. I’m not a medical person at all, but I think that it pretty much wears
and tears on other things if your blood sugars are high; so, if your blood sugars are high you’re risking a lot of different things, with your kidneys, with, you know, a lot of stuff. So, I think that probably that the two go hand in hand.

Participants described other potential ‘links’ between these two diseases related to diet, lack of physical activity, genetics, hormones, and being overweight. One participant summarized these connections nicely:

I never thought about it, you know; diet and exercise affect heart disease and diet and exercise affect diabetes, so it would make perfect sense. And genetic factors are both there, too. Being Native American, I am predisposed to both those things because our diet has changed so drastically in the last century.

Some participants expressed the belief that these two diseases are unrelated. Most commonly, women supported this view with the idea that the diseases involve different elements – blood sugar in diabetes and cholesterol in CVD. For example, one participant voiced that, “I just think that . . . it’s just two different diseases. And I think one is sugar and the other one is cholesterol. It’s just two different elements.” Similarly, another participant described her thoughts:

Because to me the heart disease is caused by fat in your blood, and then the sugar – the only way I can think is that maybe it’s caused together by the sugar and the fat in your blood, but to me, they’re separate and they’re not together. You’ll have them together because you usually, when you’re eating something, you’re eating like a fried donut with lots of sugar! Okay, that’s together. If I was just eating pure sugar, I don’t think my cholesterol would be high and I think it’s the cholesterol that’s going to cause your heart disease. So, I’m not sure . . . So, I
think it’s just more trying to eat right – that’s the whole thing. But, I don’t think they’re tied together, I really don’t.

**Level of confidence.** Participants were asked to describe their confidence, a concept similar to that of self-efficacy, related to their ability to prevent T2DM and/or CVD. Consistently, women dichotomized themselves into two groups: the “pretty confident” group or the “not very confident” group. Fewer participants considered themselves confident to prevent disease; however, these women related their degree of confidence to factors such as enjoying healthy foods and outdoor activities requiring physical exertion. A few reported success in recent weight loss efforts or adherence to prescribed antihypertensive and antidyslipidemic medication as reasons for their confidence. The majority of participants, however, expressed either low or no confidence related to their ability to prevent T2DM and/or CVD. One participant explained:

No and I think I just don’t think about it, because, in my head, it’s [T2DM] coming. It’s gonna come. Maybe I should flip a switch and think that it’s preventable and start taking the defensive of prevention instead of settling. But, I’ve never thought about it like that – as a prevention thing.

Participants frequently referenced the experiences of their family members when describing their own lack of confidence. One participant with T2DM described her feelings: “I know it’s gonna happen. I know I can’t prevent it [CVD]. I may be able to prolong it. Nobody’s lived past 56 in my family. Heart disease, cancer – all due to diabetes.” Participants with diabetes often used language such as “having all the cards stacked against you,” and “constant tug-of-war” to describe their feelings related to their lack of confidence to prevent CVD. The participants without T2DM also used similar
terminology to describe their feelings related to their own lack of confidence to prevent diabetes.

**Hope.** Whereas most women expressed low confidence for preventing T2DM and/or CVD, many expressed hopefulness related to prolonging the onset of disease. Many women also conveyed the hope that current lifestyle behavioral changes would minimize the severity of T2DM and/or CVD or contribute to making these diseases more manageable. The word ‘hope’ surfaced frequently in the interviews as women made statements such as, “hope in my head I don’t get it [T2DM];” or “hope I’m one of the lucky ones;” or “hopefully I can stall it out to where it will be later instead of just right around the corner.” The notion of ‘hanging on’ was also common among participants. That is, participants highlighted the fact that they had not been diagnosed yet, so they were still hopeful to prolong the time. One woman described it this way: “I’m not saying I’m not confident; I’m in hopes that I can [prevent T2DM]. I’m gonna try to stay positive because, knock on wood, I haven’t gotten it [T2DM] yet.”

**Prevention**

Women frequently discussed various aspects of prevention related to T2DM and CVD. More specifically, the women discussed lifestyle behaviors believed to help prolong or prevent the onset of T2DM and/or CVD and factors in their daily lives that impacted those behaviors. Three sub-categories emerged from the data including (a) barriers to prevention, (b) facilitators to prevention, and (c) uncertainty related to prevention.
**Barriers to prevention.** Women described particular factors that seemed to make it more challenging for them to incorporate preventive lifestyle behaviors into their daily lives. These barriers seemed to fall into one of three distinct groups: (a) social barriers, (b) personal barriers, and (c) diet preferences/meal preparation barriers.

Women commonly described social barriers such as busy lifestyles, stress from work or home, pressure from others, and maternal responsibilities. In a more personal sense, participants described struggling with depression, low self-esteem, frustration, and lack of discipline in their daily lives. These personal issues often acted as barriers to practicing preventive health behaviors. Over one-half of the sample in this study self-reported a diagnosed history of depression and almost one-third reported currently taking antidepressants.

Women also identified several issues related to personal diet preferences and meal preparation that acted as barriers to prevention. Several participants spoke of “craving” high fat, high sugar foods, while others reported dislike for fruits and vegetables and healthy food. One woman reported: “I crave it. I give in. And I don’t like diet food; I think it’s gross. I’ve tried to eat salads and, you know, I’m not full and I just don’t like it.” Many women spoke of the convenience of fast food in their busy lives and several others expressed how difficult it is to plan healthy meals and learn how to cook differently. When asked what she thought might make her more confident to prevent CVD, one woman with T2DM expressed:

A dietician in my home that prepares my meals for me! That would be wonderful! That way you wouldn’t have to think about it, you know. Or just
someone to set up your meal plans for you, all ready, to where you could have
easy meal plans that you know you’re going to eat.

**Facilitators to prevention.** When asked how they thought T2DM and CVD could
best be prevented, several participants discussed the need to start prevention efforts in
young children. More than one woman expressed the belief that whether or not one will
develop T2DM and CVD later in life is determined during the formative childhood years.
One woman put it this way:

Well, watching the studies that you see, as a child, even with my children, you try
to set the precedence as far as what they’re eating as a young child, on up. So, I
think if we would take more control over that then we would have a little bit
better grip on it as the child grows, and gets older, and habits and things like that.

Other participants emphasized the importance of education and awareness related
to prevention of these diseases. Several others discussed the facilitators to prevention
related to their tribal membership. These included access to healthcare for regular
preventive screening and also access to facilities such as fitness centers. One participant
who had recently completed an educational program for individuals at risk for diabetes,
offered through the tribal healthcare system, discussed the benefits of being in a support
group with other individuals who were also working hard to incorporate preventive
lifestyle behaviors in their daily lives. She found an element of accountability helpful: “I
feel more confident now since I went through the 16 week program. And when that class
is over it’s not really over because they meet once a month to see how you’re doing.”

Other women emphasized the importance of having a positive attitude or mental
outlook related to prevention. One woman expressed it this way:
I think, of course I’ve been really thinking a lot about this anyway, but I think probably sometimes we speak things into action. So, I think that in your mental – somewhere back there you’re thinking, “Well, my mom and dad are both diabetic; my mom and dad both have high blood pressure. I’m going to have high blood pressure and I’m going to be a diabetic.” So, you pretty much just keep living your life like you’re living it, knowing that that’s just going to happen. So, I think probably your mental control has a lot to do with it, but did I use that? No. But I really think that, you know. I really think that probably if we would get a grip on it mentally, younger, probably, it could be prevented.

**Uncertainty.** Women often expressed uncertainty related to their personal control to prevent T2DM and CVD or to prolong either or both of these diseases. Many women expressed uncertainty related to the inevitability versus preventability of these diseases, as well. One woman summarized her uncertainty in this way:

Well, maybe I just don’t really know that much about it, because, to me, if you’re gonna have it [T2DM or CVD] it’s kind of like in your genetics – that you’re going to have it. And I say that just because grandparents, if they’ve got it and if their parents had it, I mean, to me, that’s genetic. It’s – you’re gonna get it. And I don’t know if it really is. Is it something that could have been taught to each generation to avoid it or is it something that they did not know how to prevent? . . . I guess since I know that they’ve had it, I kind of just expect to have it. Or is it really something that’s prevented and I just need to be taught how to prevent it?
DISCUSSION

Mixed Methods Findings and Implications

Cardiometabolic Risk

The major findings from the quantitative phase of this study indicate that Oklahoma American Indian women have significant cardiometabolic risk based upon metabolic syndrome diagnostic criteria and insulin resistance. The prevalence of metabolic syndrome in our sample of women (61.9%) was significantly higher than the prevalence reported among American Indian women in the EARTH study (47.3%) (Schumacher et al., 2008) and in American Indians in the Strong Heart Study (35%) (Resnick et al., 2003). Similar to the findings from the EARTH study, we found that the most common component of the metabolic syndrome was increased waist circumference. Of women in the sample who were categorized as having metabolic syndrome, 23.1% had self-reported diabetes, similar to the 26% prevalence rate of diabetes among American Indian women with the metabolic syndrome reported in the EARTH study (Schumacher et al.). The average BMI of women in the study (34.39 kg/m²) was higher than the average BMI of any of six cohorts represented in a recent systematic review examining the health beliefs and lifestyle behaviors of women with pGDM (Jones, Roche, & Appel, 2009).

The prevalence of insulin resistance (based upon HOMA-ir > 2.7) in the sample (72.2%) was very high. The mean fasting insulin value for our sample was 23.82 µU/mL compared to the mean value of 17.31 µU/mL among American Indian women in the Inter-Tribal Heart Project (Greenlund et al., 1999) and 14.2 µU/mL in American Indians in the Strong Heart Study (Resnick et al., 2003). Many clinicians use 17 µU/mL as a cut
point for insulin levels that indicate insulin resistance (Monzillo & Hamdy, 2003). HOMA-ir has been shown to be an accurate and useful indicator of insulin resistance when calculated in euglycemic patients such as those in our sample (mean fasting glucose = 99.16 mg/dL) (Appel, 2005; Hanley et al., 2002; Matthews et al., 1985). Insulin resistance often exists before other components of the metabolic syndrome (Ferrannini, Barrett, Bevilacqua, & DeFronzo, 1983; Ridker, Buring, Cook, & Rifai, 2003); therefore, it is vital to screen euglycemic American Indian women for insulin resistance. As expected, there was a strong positive correlation between HOMA-ir values and presence of metabolic syndrome in the sample ($r_s = .711; p = .001$), with fasting glucose as a recognized covariate.

Similar to the cohort of American Indian women in the Strong Heart Study (Howard et al., 1999), the women in our study displayed increased prevalence of reduced HDL-C (66.7%), elevated LDL-C (75.0%), and elevated triglycerides (28.6%). Seven (33.3%) women in our sample were categorized as having ‘prediabetes’ based on their impaired fasting glucose values (>100mg/dL) (ADA, 2005). Early recognition of metabolic syndrome and insulin resistance in this population of women with prediabetes is essential if T2DM and CVD are to be prevented or delayed.

**Knowledge of Cardiometabolic Risk Factors**

Quantitative findings revealed relatively high levels of knowledge related to diabetes and CVD risk factors. As previous studies have shown (Kim et al., 2007b; Swan et al., 2007), increased knowledge of risk factors does not necessarily lead to increased risk perception or self-efficacy to carry out risk-reducing lifestyle behaviors. However,
in contrast to the findings of the study by Kim et al., the women in our study had both increased knowledge and increased risk perception for these diseases. Findings showed that 84.2% of our sample had moderate to high risk perceptions related to developing diabetes and 59.1% had moderate to high risk perceptions related to developing CVD. While there were no statistically significant correlations between knowledge and risk perceptions, the qualitative data revealed that women’s knowledge, including knowledge received by providers or anecdotal knowledge of others’ experiences with T2DM and CVD, contributed greatly to their personal risk perceptions for these diseases. The qualitative data indicates that knowledge of cardiometabolic risk factors clearly influences women’s risk perceptions for disease.

While correlations between risk factor knowledge and certain cardiometabolic risk factors such as LDL-C and systolic blood pressure were statistically significant in our sample, it is difficult to determine if these correlations are of practical significance. Perhaps conversations with health care providers regarding risk conferred by elevated blood pressure or cholesterol in the primary care setting could lead to increased knowledge; however, there were no significant differences in knowledge scores between women who were currently treated with antihypertensive and antidyslipidemic medication and those who were not. Again, we can look to the qualitative data to shed light on these questions. When probed for information regarding knowledge of risk factors, women frequently reported receiving information from their providers related to their risk for T2DM and CVD. It seems, then, that women’s knowledge was increased by providers’ preventive counseling. Similarly, a recent study revealed that women with pGDM recalled healthcare provider discussions about diabetes risk and lifestyle
modification; however, recall of such advice was insufficient for women to achieve lifestyle changes (Kim et al., 2007a). While we know that mere education is often not sufficient to produce necessary lifestyle behavioral changes, it remains a key factor that should not be overlooked in preventive interventions in this population.

An interesting finding, and one that is somewhat difficult to explain, was that knowledge of diabetes risk factors was inversely correlated with the presence of certain risk factors (LDL-C, fasting glucose, and fasting insulin), while knowledge of CVD risk factors was positively correlated with the presence of certain risk factors (LDL-C, systolic blood pressure). In addition, although not statistically significant, Pearson’s correlations revealed an inverse correlation between diabetes knowledge and CVD knowledge ($r = -0.287; p = 0.234$), even though average scores of both variables were relatively high. One possible explanation might be that these women do not comprehend the ‘big picture’ related to cardiometabolic risk. That is, women may view risk for diabetes in a completely different context than they view cardiovascular risk. Women may view diabetes risk as more imminent and harmful related to potential health outcomes such as amputation and dialysis, while they may fail to recognize the imminent harm conferred by CVD. Given this possible interpretation, women’s health clinicians should emphasize the relationship between T2DM and CVD in patient education and clearly describe the health outcomes associated with both of these diseases.

**Cardiometabolic Risk Perception**

A recent concept analysis of risk revealed that current use of the word in our society signifies a concept laden with associations of value, and, when related to risk for
disease, the association is almost always negative (Jacobs, 2000). The participants’ conceptualizations of risk in this study were consistent with those in the literature (Jacobs) as the majority of women associated risk with danger and trouble.

Qualitative data supports the statistically significant correlation between family history of diabetes and risk perception for diabetes among women in our study. In fact, one of the primary findings from the qualitative analysis related to risk perception was the identification of the concept of situational risk perception related to family history and genetic risk. Women who had family members with T2DM and/or CVD frequently reported feeling that they were at increased risk for these diseases. Likewise, data from the interviews supports the correlation between risk perception for CVD and the diagnosis of diabetes. Each of the three women with diabetes reported low confidence for preventing CVD related to the increased risk conferred by T2DM. Again, these women referenced conversations with their healthcare providers that increased their risk perception for developing CVD in the future.

**Self-Efficacy to Prevent Cardiometabolic Disease**

Personal control scores in the quantitative data revealed high personal control related to preventing diabetes in our sample. In this respect, there is not agreement between the quantitative and qualitative data pertaining to personal control related to health risks. The women commonly expressed their efforts to “try” to control lifestyle behaviors, but they also emphasized the difficulty they frequently encountered when trying to do so. Present day patterns of American Indian cooking, family member’s food
preferences, and the importance of food in social events often made it difficult for women to exert personal control related to lifestyle behaviors.

While we found a statistically significant positive correlation between family history of CVD and personal control related to developing diabetes, it is likely that this correlation has little to no practical significance. Women frequently reported feeling very little personal control related to the risk for T2DM and CVD conferred by family history and genetics.

Quantitative data revealed relatively low optimistic bias scores, indicating that the women felt that they were at greater risk for developing diabetes compared to other women of the same age. This finding is consistent with the findings of a previous study addressing self-perceived health status of women with pGDM in which the authors report women were worried about their own health and perceived themselves as more likely to have diabetes (Feig, Chen, & Naylor, 1998). This finding is also consistent with our qualitative findings. Women frequently described the belief that they were likely to develop diabetes. In fact, some women expressed surprise that they had not yet developed the disease. However, women commonly expressed optimism related to delaying the onset of T2DM and CVD. This is an important finding, for it gives clinicians insight into American Indian women’s expectations and beliefs related to practicing cardiometabolic risk-reducing lifestyle behaviors.

Quantitative data revealed a statistically significant inverse correlation between optimistic bias and history of depression among women in our sample. While qualitative data revealed various reasons for women’s relatively low optimistic bias related to developing diabetes, the relationship between self-efficacy to carry out risk-reducing
lifestyle behaviors, in general, and depression may warrant further exploration. The prevalence of depression in persons with diabetes, as well as the distress related to managing diabetes, has been given well-deserved attention (Lloyd, Pambianco, & Orchard, 2010). An unexpected yet important finding in this study was that 13 (59.1%) women reported a history of depression and, of these, seven (31.8%) were currently taking an antidepressant. Prior to designing effective interventions aimed at increasing self-efficacy to prevent cardiometabolic disease, researchers should explore the impact of depression on self-efficacy to practice preventive lifestyle behaviors among American Indian women.

We found that the majority of women reported lacking motivation to change lifestyle behaviors in the presence of high levels of knowledge and high risk perception. This finding is consistent with the findings of other studies examining health behavior change (Rimal & Real, 2003). This element of motivation is related to self-efficacy, or individuals’ beliefs in their abilities to produce effects (Bandura, 1986). Theories of health behavior change, such as the Health Belief Model, have conceptualized perceived risk as a motivator of change (Janz & Becker, 1984); however, in order to enact change, motivation must be facilitated by the belief that something can be done to avert the threat. If individuals are to change, they must feel efficacious in their ability to change (Bandura; Rimal, 2000). The findings from this study indicate a need to further address the element of self-efficacy as we design interventions to decrease cardiometabolic risk in American Indian women with pGDM.
Limitations

Limitations of this pilot study include the small sample size with participants from one tribal health care system. The small sample size may have affected study findings due to a lack of statistical power. Because of the cross-sectional nature of the study, no inferences could be made with respect to causality. Also, it is not possible to know with certainty the direction of the relationships among cardiometabolic risk factors, knowledge, risk perceptions, and self-efficacy. For example, it is difficult to know whether women who report low personal control related to developing diabetes feel this way as a result of their depression or if their feelings related to their lack of personal control contribute to their depression.

Convenience sampling through this particular health care system may have contributed to self-selection bias and a resulting nonrepresentative sample. The tribal health care system offers an intense educational program to pregnant women with GDM. This level of prenatal education for women with GDM and the follow-up diabetes screening this health system offers to women at six weeks postpartum is not common in the US (Kim et al., 2007a). It would be reasonable to expect that women receiving their prenatal care through this health system might have different levels of knowledge, cardiometabolic risk perceptions, and self-efficacy beliefs to carry out risk-reducing behaviors than American Indian women receiving prenatal care in locations where such programs are not available. In addition, women in this study were well-educated with about half reporting attending some college and half completing college degrees. Conducting the same study among a sample of less-educated women could have
produced different findings related to cardiometabolic knowledge, risk perceptions, and self-efficacy beliefs.

Another potential bias in the study is that of social desirability. The participants may have offered perceived professionally correct responses, either on the surveys, which were completed with the assistance of the PI to avoid potential issues with illiteracy, or during the interviews.

Although the pilot study had its limitations, it also had several strengths. First, the mixed methods design allowed for the estimation of cardiometabolic risk in the sample as well as the description of relationships among risk factors and cardiometabolic knowledge, risk perception, and self-efficacy to prevent T2D and CVD. The rich qualitative description from the in-depth interviews served to explain and illuminate the quantitative findings and contributed to an understanding of the quantitative data that would not have been otherwise possible. This study added significantly to the body of nursing knowledge addressing cardiometabolic health disparities in minority populations, specifically among American Indian women. This population has historically been underrepresented in research despite their increased rates of cardiometabolic disease.

In addition, this study revealed a relationship of potential clinically practical significance between depression and self-efficacy to practice preventive lifestyle behaviors in American Indian women with pGDM. The findings of this study may be foundational for future studies addressing prevention of cardiometabolic disease among American Indian women and other high-risk populations.
Implications for Research and Practice

The quantitative portion of this study should be replicated with a larger sample of American Indian women from various tribes and geographic locations. Research is further warranted in order to identify effective ways to increase women’s self-efficacy to carry out preventive lifestyle behaviors with the overall aim to decrease cardiometabolic disease in this population. A clear area for development is a theoretical framework that more specifically takes into account the cultural context of the lives of childbearing American Indian women. In addition, there is a need to identify culturally appropriate instruments to measure knowledge, risk perception, and self-efficacy in this population, as this has not been done, to our knowledge. Based on the findings from this study, interventions to reduce risk should take into account an understanding of how traditional American Indian culture influences women’s health behaviors, including the deep cultural meaning inherent in food in American Indian society. In addition, future interventions should involve women’s families, as family members’ health beliefs and behaviors clearly impact those of American Indian women. In addition, researchers should explore the relationship between depression and decreased self-efficacy to practice preventive lifestyle behaviors in women with pGDM.

Finally, we found that childbearing American Indian women with pGDM have significant cardiometabolic risk based upon metabolic syndrome diagnostic criteria and insulin resistance. Unfortunately, after pregnancy ends, women with pGDM fall into a gap in our health care systems where they often do not receive preventive screening and education related to decreasing risk for T2DM and CVD. Women with pGDM are an easily identifiable population in which preventive interventions should be implemented.
during and immediately following delivery. Researchers and clinicians are faced with the challenge to design interventions that directly address this gap and ensure that women with pGDM have access to education and tools that will increase their risk perception and self-efficacy to prevent cardiometabolic disease.
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CONCLUSIONS

The development of cardiometabolic disease depends upon the synergistic combination of risk factors from interrelated spheres including genetics, environment, and metabolic abnormalities. Given our ability to reduce environmental and metabolic risk with preventive lifestyle behaviors, it is possible to reduce American Indian women’s risk for T2DM and CVD following GDM. However, prior to the development of interventions aimed at doing this, researchers and clinicians must understand childbearing women’s risk perceptions, health beliefs, and self-efficacy beliefs related to practicing preventive lifestyle behaviors.

Given the increasing prevalence of T2DM and CVD in American Indian women with pGDM (Bentley-Lewis, 2009; Kim, Newton, & Knopp, 2002), we must devote greater attention and resources to implementing effective strategies for promoting accurate risk perception and increasing self-efficacy to carry out risk-reducing health behaviors in this high-risk population. These interventions should take into account an understanding of how traditional American Indian culture influences women’s health beliefs and behaviors. In addition, understanding the context of childbearing women’s lives should contribute to the development of family-oriented interventions in this population. The high prevalence of depression among women in this pilot study indicates the need for further exploration of the relationship between depression and self-efficacy to practice preventive lifestyle behaviors. Finally, it is the responsibility of women’s health researchers and clinicians to intervene in culturally sensitive and effective ways
during pregnancy, immediately following pregnancy, and throughout the childbearing years, in order to decrease cardiometabolic risk among American Indian women with previous GDM.
REFERENCES


diabetes: effects of metformin and lifestyle interventions. *Clin Endocrinol Metab, 93, 4774-9.*


APPENDIX A

UNIVERSITY OF ALABAMA AT BIRMINGHAM
INSTITUTIONAL REVIEW BOARD APPROVAL
Form 4: IRB Approval Form

Identification and Certification of Research Projects Involving Human Subjects

UAB's Institutional Review Boards for Human Use (IRBs) have an approved Federalwide Assurance with the Office for Human Research Protections (OHRP). The Assurance number is FWA00005960 and it expires on October 26, 2010. The UAB IRBs are also in compliance with 21 CFR Parts 50 and 56 and ICH GCP Guidelines.

Principal Investigator: JONES, EMILY J
Co-Investigator(s): APPEL, SUSAN J
Protocol Number: X090818001
Protocol Title: Cardiometabolic Risk and Risk Perception Among Oklahoma American Indian Women with Previous Gestational Diabetes

The IRB reviewed and approved the above named project on 10/1/09. The review was conducted in accordance with UAB's Assurance of Compliance approved by the Department of Health and Human Services. This Project will be subject to Annual continuing review as provided in that Assurance.

This project received EXPEDITED review.

IRB Approval Date: 10-01-09
Date IRB Approval Issued: 10/1/09

Marilyn Doss, M.A.
Vice Chair of the Institutional Review Board for Human Use (IRB)

Investigators please note:

The IRB approved consent form used in the study must contain the IRB approval date and expiration date.

IRB approval is given for one year unless otherwise noted. For projects subject to annual review research activities may not continue past the one year anniversary of the IRB approval date.

Any modifications in the study methodology, protocol and/or consent form must be submitted for review and approval to the IRB prior to implementation.

Adverse Events and/or unanticipated risks to subjects or others at UAB or other participating institutions must be reported promptly to the IRB.

470 Administration Building
701 20th Street South
205 334-3780
Fax 205 334-1301
irb@uab.edu

The University of Alabama at Birmingham
Mailing Address:
AB 470
1530 3RD AVE S
BIRMINGHAM AL 35294-0104
APPENDIX B

INFORMED CONSENT FORM
Informed Consent

TITLE OF RESEARCH: Cardiometabolic Risk and Risk Perception Among Oklahoma American Indian Women with Previous Gestational Diabetes

IRB PROTOCOL: X090818001

INVESTIGATORS: Emily J. Jones, BSN, RNC-OB
Susan J. Appel, PhD, ACNP-BC, FNP-BC, CCRN

Explanation of Procedures

You are being asked to take part in a research study designed to examine the presence of risk factors for type 2 diabetes and cardiovascular disease in Oklahoma American Indian women who were diagnosed with gestational diabetes in a previous pregnancy. The purpose of this study is to find out what you believe about your health risks for developing diabetes or cardiovascular disease after being diagnosed with gestational diabetes and what you believe about your ability to prevent these diseases. If you are currently pregnant we ask that you do not participate in this study.

You have the right to learn about the study’s risks and benefits before you decide whether you would like to participate in this study. This is called informed consent. If you have any questions regarding the study, please feel free to speak to the study’s investigator about those questions now or at any future time. The form you are reading describes the research study in which you are being asked to participate. If you decide to participate in this study, you will be asked to sign this form. You will be given a copy of this form to keep.

Women who participate in this study will be asked about their personal health beliefs and perceptions of risk related to having previous gestational diabetes. Also, to determine your level of risk for diabetes and heart-related diseases, these tests will be made in the study: lab blood tests, weight and height measures, and blood pressure. You will be asked to fast (not eat or drink anything other than water) for 12 hours prior to the collection of the lab blood tests. This study will enroll approximately 25-30 participants who receive their health care from the Chickasaw Nation Health Systems (CNHS).

Orientation/First Visit

At the first visit, you will meet with the study investigator in a private setting of your choice or in a private room at the CNHS Diabetes Care Center. The study investigator will review this consent form with you. The total time for the orientation visit will be approximately 30 minutes. If you choose to participate after having your questions answered, you will be asked if you wish to complete three short surveys at this time. The study investigator will read over each of the surveys with you. This will take approximately 30 to 45 minutes. You will also be asked if you are willing to participate in an additional interview for the study. The interview will last about 60 to 90 minutes. In the interview, you will be allowed to clarify anything by expa

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Expiration Date 10/1/10

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your responses to the survey questions. This interview will be recorded with an audio-voice recorder in order for the investigator to be able to listen to it again at a later time. If you complete the surveys and interview at this time, this first visit will take about 2 to 2.5 hours.

Second Visit/Labwork

This visit will be scheduled for another time convenient for you within the following week, likely in the morning hours, so that you can be in the fasting state for 12 hours prior to this visit when you arrive at the CNHS. First, we will weigh you, measure your height and waist circumference, and check your blood pressure. We will then draw a small sample of your blood to measure blood glucose (sugar), lipids (fats), and insulin. After your blood work has been drawn, you will be offered a light snack. It will take approximately 1 hour to collect your labwork and other measurements. At this point, if you have not already completed the surveys, you will be asked to do so at this time. If you have not already done so, you will also be asked if you wish to participate in the additional interview at this time. Completion of the surveys will take about 30 to 45 minutes and the interview will take about 60 to 90 minutes. This will conclude your participation responsibilities in the study.

Risks and Discomforts

There are no major risks associated with the data collection visits. It is possible that discussion related to health risks of diabetes and heart-related diseases may cause some women to be apprehensive or uncomfortable, although this is a minor risk. Due to the length of the interview, there is a risk of fatigue. If necessary, you will be allowed to rest during the interview session. All medical lab tests are routine clinical procedures but may involve some minor risks or discomforts. While rare, the risks of drawing blood for the study include the possibilities of brief pain, becoming faint during the blood draw, or developing a bruise or bump following the blood draw. There is also a slight risk of infection at the site where the blood was taken. If you experience any of these uncomfortable symptoms, the Principal Investigator and the staff of the CNHS will assist you.

Benefits

You will potentially benefit from this study by gaining knowledge related to risks for future type 2 diabetes and heart disease and lifestyle behaviors that may decrease your risk. The laboratory tests are also a benefit of the study. You will be given a report of your laboratory values to keep and discuss with your doctor. Also, your primary care provider will be notified of your participation in the study in order that any abnormal lab results may be addressed after the completion of the study. Finally, other American Indian women with previous gestational diabetes served by the CNHS and women in other American Indian communities may benefit from effective diabetes and heart disease prevention interventions informed by the results of this study.

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Alternatives

If you choose to not participate in this study, you may talk to your doctor about healthy lifestyle behaviors that will decrease your risk for diseases like diabetes and heart disease. Your usual health care will not be affected whether you join the study or not.

Confidentiality

Information obtained about you for this study will be kept private to the extent allowed by law. Records about you will be put under a code number. In order to ensure that we can keep in contact with you, we will record some personal information and this will be stored in a locked file cabinet and secured password-protected database. Audiotapes of individual interviews will be reviewed for quality control purposes, but only study investigators will have access to the tapes and individuals on the tapes will not be identified. Audiotapes will be transcribed and destroyed as quickly as possible. The results of the study may be published, but your identity will not be given, and the results will be given only for groups of people, not individuals. Any medical information about you will be kept in computer records for analysis with such information from all other individuals in the study, but these records will not contain your name, or Social Security or medical record number, or any other information that could identify you. Data will be securely stored in a locked file cabinet in the personal office of the Principal Investigator and on the personal computer of the Principal Investigator and dissertation committee members' computers within the School of Nursing and School of Medicine at the University of Alabama at Birmingham. Data files will be password protected, and no one other than the Principal Investigator and the five members of her dissertation committee will have access to the data.

To ensure that your rights as a participant are being properly maintained, research information that identifies you may be shared with the University of Alabama at Birmingham (UAB) Institutional Review Board (IRB), the CHNS IRB, and others who are responsible for ensuring compliance with laws and regulations related to research such as the Office for Human Research Protections (OHRP). Medical information released may include communicable disease information.

This consent document will be placed in your file at the CNHS. The document will become part of your permanent medical record.

Report of Study Results to Healthcare Providers

All laboratory results and biophysiological measures will be reported to your healthcare provider for appropriate follow-up. At the end of the study, the findings will be shared with your healthcare provider and administration of the CNHS prior to publishing the findings.
Refusal or Withdrawal without Penalty

Taking part in this study is your choice. There will be no penalty if you decide not to be in the study. If you decide not to be in the study, you will not lose any benefits you are otherwise owed. You are free to withdraw from this research study at any time. Your choice to leave the study will not affect your relationship with the CNHS or your doctor(s).

Cost of Participation

There will be no cost to you for taking part in this study other than the cost of gasoline for driving to the health center for research activities. All lab tests related to this study will be provided to you at no cost.

Payment for Participation in Research

For participating in this research study, you will be compensated with a Wal-Mart gift card. If you choose to participate in the study, you will receive a $15 gift card after the completion of survey data and laboratory tests. If you choose to participate in the additional interview, you will receive an additional $10 on the gift card for a total of $25. If you choose to withdraw from the study after completion of the surveys and/or interviews, but before collection of laboratory data, you will still receive a $15 gift card. Likewise, if you choose to withdraw after the collection of laboratory data, but prior to the collection of survey and/or interview data, you will receive a $15 gift card.

Payment for Research-Related Injuries

UAB has not provided for any payment if you are harmed as a result of taking part in this study. In spite of minimal risk, treatment for any research-related injuries will be provided to you at no cost as part of the usual benefits of the CNHS.

Significant New Findings

You will be told by your doctor or his/her staff if new information becomes available and might affect your choice to stay in the study.

Questions

If you have any questions, concerns, or complaints about the research, please contact the Principal Investigator, Emily Jones, at 405-364-1796 (home) or 405-397-5783 (cell). If you have questions about your rights as a research participant, or concerns or complaints about the research, you may contact Ms. Sheila Moore. Ms. Moore is the Director of the Office of the Institutional Review Board for Human Use (OIRB). Ms. Moore may be reached at 205-934-3789 or 1-800-822-8816. If calling the toll-free number, press the option for "all other calls" or for an operator/attendant and ask for extension 3789. Regular hours for calls are 8:00 to 5:00.
a.m. to 5:00 p.m. CT, Monday through Friday. You may also call this number in the event the research staff cannot be reached or you wish to talk to someone else.

Legal Rights

You are not waiving any of your legal rights by signing this informed consent document.

Signatures

Your signature below indicates that you agree to participate in this study. You will receive a copy of this signed document.

Signature of Participant

Date

Signature of Investigator or other person obtaining consent

Date

Signature of Witness

Date

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AUTHORIZATION FOR USE/DISCLOSURE OF HEALTH INFORMATION
FOR RESEARCH

What is the purpose of this form? You are being asked to sign this form so that UAB may use and release your health information for research. Participation in research is voluntary. If you choose to participate in the research, you must sign this form so that your health information may be used for the research.

Participant Name: ____________________________
UAB IRB Protocol Number: ______________________
Research Protocol: ____________________________
Principal Investigator: _______________________
Sponsor: ____________________________

What health information do the researchers want to use? All medical information and personal identifiers including past, present, and future history, examinations, laboratory results, imaging studies and reports and treatments of whatever kind related to or collected for use in the research protocol. Medical information released may include communicable disease information.

Why do the researchers want my health information? The researchers want to use your health information as part of the research protocol listed above and described to you in the Informed Consent document.

Who will disclose, use and/or receive my health information? The physicians, nurses and staff working on the research protocol (whether at UAB or elsewhere); the Principal Investigator of the study and the dissertation committee members of the Principal Investigator; the IRB and its staff.

How will my health information be protected once it is given to others? Your health information will only be received and used by parties responsible to follow the federal privacy laws. Your health information will not be shared with outside organizations that are not required to follow federal privacy laws.

How long will this Authorization last? Your authorization for the uses and disclosures described in this Authorization will expire 10 years from the date the Authorization is signed with the provision that the Principal Investigator may request an extension if necessary.

Can I cancel the Authorization? You may cancel this Authorization at any time by notifying the Director of the IRB, in writing, referencing the Research Protocol and IRB Protocol Number. If you cancel this Authorization, the study doctor and staff will not use any new health information for research. However, researchers may continue to use the health information that was provided before you cancelled your authorization.

Can I see my health information? You have a right to request to see your health information. However, to ensure the scientific integrity of the research, you will not be able to review the research information until after the research protocol has been completed.

Signature of participant: ____________________________
Date: ____________
or participant’s legally authorized representative: ____________________________
Date: ____________
Printed Name of participant’s representative: ____________________________
Relationship to the participant: ____________________________

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APPENDIX C

CHICKASAW NATION DIVISION OF HEALTH
INSTITUTIONAL REVIEW BOARD APPROVAL
Emily J. Jones, BSN, RNC
PhD Student, School of Nursing
University of Alabama at Birmingham
4000 Nalon Drive
Norman, OK 73072

Dear Ms. Jones:  

On September 18, 2009 the Chickasaw Nation Health System Institutional Review Board (CNHS IRB) reviewed the proposal that you submitted entitled "Cardiometabolic Risk, Knowledge, Risk Perception, and Self-Efficacy among Oklahoma American Indian Women with Previous Gestational Diabetes". The proposal named you as the principal investigator. It is the judgment of the board that the rights and welfare of participants will be respected, no more than minimal risk is involved and that the research study including the consent process is consistent with the requirements of 45 CFR 46 or 21 CFR 50 and 56 as amended. The board therefore has voted to approve your proposal.

This letter documents approval for: Cardiometabolic Risk, Knowledge, Risk Perception, and Self-Efficacy among Oklahoma American Indian Women with Previous Gestational Diabetes

This approval is granted for a period of one year(s), until August 31, 2010, and must be reviewed annually. Authorization is contingent on compliance with all Chickasaw Nation research policies and procedures. No changes can be made to the research protocol without receiving prior written authorization from the CNHS IRB. The CNHS IRB may require the researcher to amend the original application, limit the scope of research activities or rescind the research permit should research conditions change during the course of the project. Any data collection, research results, manuscripts or abstracts must be submitted and approved by the CNHS IRB prior to use for publication or presentation in any form.

If you have any questions, please contact Michael Peercy at the address listed below or at (580) 272-2737.

Carl Albert Indian Health Facility
1001 N. Country Club Road
Ada, OK 74820

Sincerely,

Bobby Saunkeah, Chair
Chickasaw Nation Health System
Institutional Review Board