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Awareness of Diabetes Risk and Adoption of Diabetes Risk Reduction Behaviors in the Presence of Other Risk Factors in U.S Adults: An Examination of NHANES Data 2007-2008

Payal S. Shah
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AWARENESS OF DIABETES RISK AND ADOPTION OF DIABETES RISK REDUCTION BEHAVIORS IN THE PRESENCE OF OTHER RISK FACTORS IN U.S ADULTS:

AN EXAMINATION OF NHANES DATA 2007-2008

by

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APPROVAL PAGE

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PAYAL SURESH SHAH

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Date

DEDICATION

To my Mother for all her love, support, and sacrifice. To my sister for her encouragement, faith and believing in me. To Milan bhai for showing, directing, and guiding me on the right path of life and lastly to my Father who couldn’t be here, but for allowing me to fulfill his dream.

Thank You.

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NAI Contractor for Centers for Disease Control and Prevention (CDC)
• Completed data abstraction actions of Public Health Assessments, Health Consultations, and Technical Assistance documents.
• Reviewed, evaluated, and analyzed content of these documents to ensure they are scientifically and technically sound to successfully abstract data into Sequoia database.
• Completed Quality Assurance (QA) for public health documents and reviewed the information entered by other abstractors to determine whether information is entered in database correctly. This process enhances the way partners are completing the work and the nature of the data contained in the documents to ensure that the abstraction process contain the information needed to accurately reflect the information about individual sites in the Agency's database.
• Identified data gaps in documents that needed to be filled in order to have good quality data in Sequoia database.
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<u>Assistant Research Scientist</u>, Spring 2008-Spring 2009, Athens, Ga

Complex Carbohydrate Research Center
• Conducted experiments using methods such as centrifugation and dialysis to acquire data that can be used to solve problems and substantiate hypothesis and theoretical assumptions.
• Analyzed the peptidoglycan of *Bradyrhizobium japonicum* bacteria to examine the cause for the symbiotic relationship with plants that allow for nitrogen fixation.
• Used different methods of analysis ie: HPLC, MALDI, and GC-MS to verify and confirm data obtained from the different methods and to examine for consistency.

• Contributed to scientific articles on projects that are still being further researched for publishing.
• Analyzed *Bacillus cereus* strain 14579 to discover sugars in the secondary cell wall polysaccharide that contribute to the virulent behavior of bacteria than can aid in the production of a vaccine against anthrax infections. Project is in collaboration with Centers for Disease Control and Prevention

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ABSTRACT

Background: Prediabetes is a precursor condition to type 2 diabetes mellitus. Previous research and clinical trials have shown that the onset of type 2 diabetes could be delayed or prevented through structured life style modifications such as dietary changes, modest weight loss and moderate-intensity exercise. This study examines U.S adults of different ethnicities that include non-Hispanic white, non-Hispanic black and Mexican Americans and whether their awareness of diabetes risk is associated with their participation in diabetes risk reduction behavior, a combination of physical activity, weight control and fat/calories intake.

Methods: The 2007-2008 National Health and Nutrition Examination Survey, NHANES, was used to conduct a cross-sectional study of 4083 U.S. adults who were 20 years old and above and were aware of their diabetes risk. The association between the awareness of one's diabetes risk and the adoption of diabetes risk reduction behavior were examined in present of other risk factors such as age, gender, ethnicity, education, annual family income, BMI, hypertension, mean systolic blood pressure, mean diastolic blood pressure, total cholesterol, LDL, HDL and triglyceride levels. Males and females were examined separately for all analyses performed. Cross tabulation was conducted and p-values were calculated by the Pearson's chi-square test for the categorical variables which include gender, ethnicity, education, annual family income, adiposity and hypertension. One Way ANOVA and Tukey post hoc tests were conducted for the continuous variables which include age, mean systolic blood pressure, mean diastolic blood pressure, total cholesterol, LDL, HDL and triglyceride levels. Univariate and multivariate analyses were performed to determine the association between the main independent variable, awareness of one's diabetes risk, and the dependent variable, adoption of diabetes risk reduction behavior, controlling for other risk factors. A p-value of <0.05 and 95% confidence intervals were used to determine statistical significance throughout all analyses performed.

Results: After controlling for age, gender, race, education, annual family income, BMI, hypertension, mean systolic blood pressure, mean diastolic blood pressure, total cholesterol, LDL, HDL, and triglycerides, results from the multivariate analysis showed that subjects who were aware of their diabetes risk were more likely to adopt diabetes risk reduction behavior (OR= 1,734, 95 % CI=1.217-2.470). Females and non-Hispanic blacks, who were aware of their diabetes risk, were also more likely to adopt diabetes risk reduction behavior compared to males, non-Hispanic whites and Mexican Americans. An increase in the levels of education, annual family income and BMI was also associated with the adoption of diabetes risk reduction behavior. Stratification according to gender and ethnicity, showed that Mexican American males and females were more likely to engage in diabetes risk reduction behavior compared to non-Hispanic whites and non-Hispanic blacks (Mexican American males: OR: 2.496, CI: 0.792-7.868; Mexican American females: OR: 2.830, CI: 0.917-8.736).

Conclusion: This study provides useful insights for health care providers and public health professionals who are developing health promotion and prevention interventions to address pre diabetes before it develops into type 2 diabetes. This study also allows the development of tailored interventions for specific genders and ethnic groups that are at risk. Results of this study indicate that Mexican Americans and females (in general) are more likely to adopt diabetes risk reduction behavior. Therefore, physicians and health care providers should develop culturally, linguistically and gender- specific education materials and programs for this particular gender and ethnic group. This in turn, may reduce the overall increasing prevalence of diabetes, reduce racial and gender disparities and may have a positive impact on the overall health of the U.S. population.

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CHAPTER I

INTRODUCTION

1a. Background

Diabetes mellitus is a metabolic disease condition characterized by hyperglycemia, or high blood glucose levels, which results from defects in insulin secretion, insulin action or both (Narayan, Zhang, Kanaya, Williams, Engelgau, Imperator &Ramachandran, 2006). Diabetes often goes undiagnosed because of its many symptoms that may seem to be harmless. For example, symptoms may include frequent urination, unusual thirst, extreme hunger, unusual weight loss, and extreme fatigue and irritability (ADA, 2011). Therefore, many people with diabetes do not seek treatment until symptoms worsen. Diabetes takes three major forms which include Type 1, Type 2 and gestational diabetes. Type 1 diabetes usually occurs in children and adolescents and results from the destruction of the beta cells in the pancreas which leads to absolute insulin deficiency (Narayan et al., 2006). The body does not produce insulin in type 1 diabetes and only 5% of people with diabetes have this form of disease (ADA, 2011). However, with the help of insulin therapy and other treatments people can learn to manage Type 1diabetes and live a healthy lifestyle. Type 2 diabetes, which accounts for approximately 85 to 95 percent of all diagnosed cases, is usually characterized by insulin resistance in which target tissues do not use insulin properly (Narayan et al., 2006). Millions of Americans have been diagnosed with Type 2 diabetes and many more are unaware they are at high risk (ADA, 2011). In addition, research has found that some groups of Americans have a higher risk for developing type 2 diabetes than others. For example, Type 2 diabetes is more common in African Americans, Latinos, Native Americans, Asian Americans, Native Hawaiians and other Pacific Islanders (ADA, 2011).A third type of diabetes, gestational diabetes, is first recognized during pregnancy, usually around the 24^{th} week. (Narayan et al., 2006).

In addition to the three forms of diabetes, is another condition known as prediabetes in which blood glucose levels are higher than normal but not yet high enough to be diagnosed as diabetes (ADA, 2011). Prediabetes is also a condition defined as having impaired fasting glucose (plasma glucose level of 100 to < 126 mg/dL after an overnight fast), impaired glucose tolerance (plasma glucose level of 140 to < 200 mg/dL after a 2-hour oral glucose tolerance test) or both (CDC, 2008). Three different tests such as the A1C, the fasting plasma glucose (FPG) and the Oral Glucose Tolerance Test (OGTT), are used by doctors to determine if one has prediabetes (ADA, 2011). The blood glucose levels measured after these tests determine whether one has normal metabolism, prediabetes or diabetes. There are approximately 79 million people in the United States that have prediabetes and recent research has shown some long-term damage to the body especially the heart and circulatory system (ADA, 2011). Persons with prediabetes are also at an increased risk for developing type 2 diabetes, heart disease, and stroke (CDC, 2008). People that are diagnosed with prediabetes are aware of their high risk for developing diabetes. Therefore, they may engage in or adapt certain lifestyle changes that can prevent or delay development of diabetes and its complications (CDC, 2008). The benefits of engaging in risk reduction behaviors such as weight control, increased physical activity, and reduction in fat or caloric intake may outweigh the negative consequences associated with an increase in risk for diabetes. For example, the Diabetes

Prevention Program intervention trial showed that diet and exercise can lower the incidence of type 2 diabetes by 58% over 3 years among those at high risk for diabetes (CDC, 2008). Furthermore, clinical trials provide strong and consistent evidence that type 2 diabetes can be prevented or delayed in high-risk adults with dysglycemia through structured lifestyle modifications, including dietary changes, moderate-intensity exercise, and modest weight loss (Geiss et al., 2010). However, the extent to which U.S. adults with prediabetes are making lifestyle changes consistent with reducing risk is unknown (Geiss et al., 2010). Additional research is also needed to determine the effect of lifestyle interventions on diabetes complications, particularly cardiovascular outcomes (Geiss et al., 2010).

Successful prevention trials, in combination with subsequent practical trials implemented in community settings, suggest that if people with dysglycemia can be efficiently identified and made aware of their risk status, they may be referred to effective community programs to change their levels of physical activity, dietary intake, and weight (Geiss et al., 2010). In addition, identification of high-risk states may also be useful to provide a stimulus for brief counseling by healthcare providers or for individuals to undertake self-directed behavior change (Geiss et al., 2010). Identification and awareness of prediabetes may be an important step in initiating effective lifestyle interventions (Geiss et al., 2010). Development of linguistically competent education materials for those people of different ethnicities and cultures and who are at a high risk for diabetes may encourage them to practice behaviors that may reduce or delay the onset of diabetes.

Furthermore, interventions to prevent or delay onset of type 2 diabetes in persons with prediabetes are feasible and cost effective. It is found that lifestyle interventions are more cost effective than medications (CDC, 2008). One study evaluated the cost effectiveness of a screening program for pre diabetes which was followed up by treatment with pharmaceutical interventions or lifestyle interventions (diet, exercise, or diet and exercise) in order to prevent or slow the onset of diabetes in those at high risk (Bertram, Lim, Barendregt&Vos, 2010). Results indicated that the most cost-effective intervention options were diet and exercise combined with pharmaceutical medication metformin (Bertram et al., 2010).

The gap in prevalence between those with prediabetes and those aware of their condition presents an opportunity to reduce the burden of diabetes by increasing awareness of prediabetes and encouraging adoption of healthier lifestyles and risk reduction activities (CDC, 2008). Implementation of intervention programs that are culturally and linguistically appropriate may lead high risk individuals to engage in lifestyle modifications such as diet, physical activity and weight control, which in turn may be economically and monetarily cost effective for the individual and the nation as a whole.

1b. Purpose of Study

This study will examine U.S. males and females of different ethnicities (Non-Hispanic Whites, Non-Hispanic Blacks and Mexican Americans). It will identify subjects that are aware of their health risk for diabetes and whether they will perform risk reduction behavior in present of other risk factors which include age, gender, ethnicity, education, socioeconomic status (determined from annual family income), and biological factors such as body mass index (BMI), hypertension, total cholesterol, LDL, HDL, and triglyceride levels. Although prediabetes is defined as having impaired fasting glucose or impaired glucose tolerance, but not (yet) having diabetes, this study will utilize diabetes-related questions from the National Health and Nutrition Examination Survey 2007-2008, NHANES 2007-2008, to define those individuals aware of their high risk for diabetes. The NHANES 2007-2008 questions: *Ever told you have prediabetes?* and *Ever told you have health risk for diabetes?* were used to determine an individual's awareness of their health risk for diabetes.

The identification of an individual's awareness of their health risk for diabetes or prediabetes, may encourage them to adapt life style modifications and to seek interventions to reverse their risk for diabetes. Since this study focuses on U.S. adults of different ethnicities and genders it may encourage the development of future programs and interventions specifically tailored to target those populations who are at a higher risk for diabetes.

1c. Research Questions

Question #1: Is the awareness of one's diabetes risk associated with the involvement in diabetes risk reduction behavior including ongoing weight control, increase in physical activity and fat/calories reduction?

Null Hypothesis # 1: Subjects who are aware of their diabetes risk would not be more likely to engage in diabetes risk reduction behavior compared to those who are unaware.

Alternate Hypothesis #1: Subjects who are aware of their diabetes risk would be more likely to engage in diabetes risk reduction behavior compared to those who are unaware.

Question # 2: Will the relationship between one's awareness of diabetes risk and participation in diabetes risk reduction behavior vary by race/ethnicity?

Null Hypothesis #2: The relationship between one's awareness of diabetes risk and participation in diabetes risk reduction behavior would not vary by race/ethnicity.

Alternate Hypothesis # 2: The relationship between one's awareness of diabetes risk and participation in diabetes risk reduction behavior would vary by race/ethnicity.

Question # 3: Will the relationship between one's awareness of diabetes risk and participation in diabetes risk reduction behavior vary by gender?

Null Hypothesis # 3: The relationship between one's awareness of diabetes risk and participation in diabetes risk reduction behavior would not vary by gender?

Alternate Hypothesis # 3: The relationship between one's awareness of diabetes risk and participation in diabetes risk reduction behavior would vary by gender?

CHAPTER II

LITERATURE REVIEW

The literature review examines the epidemiology of diabetes and prediabetes in the U.S and around the world and their associated risk factors. The following chapter presents scientific literature that supports the inclusion of the variables of interest in this study. Since there are very limited studies on prediabetes, risk factors for diabetes were examined as they are similar to the risk factors for prediabetes.

2a. Epidemiology of Diabetes and Prediabetes

Type 2 diabetes mellitus is a major cause of morbidity and mortality in the United States and countries around the world and may contribute substantially to health care costs (Moore, Zgibar, &Dasanayake, 2003). Diabetes affects at least 5 percent of the U.S. population, while another 3 percent of the population may have the disorder but have not been diagnosed (Moore et al., 2003). Although the epidemic of diabetes in the United States has been observed over the past 2 decades, there is an expected continued rise in the incidence of diabetes as the population ages, a continued increase in adult obesity rates, and an increase in the population of minority groups that are at high risk for diabetes (Deshpande, Harris-Hayes &Schootman, 2008). In addition, rising childhood obesity rates and the increasing diagnosis of type 2 diabetes among children and adolescents have become an increasingly serious health crisis, which will result in more people having and managing diabetes for most of their lives (Deshpande et al., 2008). In

2005, it was estimated that more than 20 million people in the United States had diabetes (Deshpande et al., 2008). Approximately 30% of these people had undiagnosed cases (Deshpande et al., 2008). In addition, an estimated 1.5 million new cases of diabetes were diagnosed. (Deshpande et al., 2008). The incidence and prevalence of diabetes mellitus are increasing with more than 135 million people affected worldwide (Moore et al., 2003). Although the incidence describes increases in the number of people affected by the disease, the prevalence describes the overall burden of the disease in the population (Deshpande et al., 2008). The National Health and Nutrition Examination Survey, NHANES, provides estimates for both diagnosed and undiagnosed diabetes (Deshpande et al., 2008). Based on prevalence estimates from NHANES for 2005, the total prevalence of diabetes (both diagnosed and undiagnosed) was estimated at 20.8 million or 7.0% of the U.S. population (Deshpande et al., 2008). Of these, 14.6 million were diagnosed and 6.2 million almost 30% of all diabetes cases were undiagnosed (Deshpande et al., 2008). In the United States, the prevalence and incidence of diabetes have increased dramatically during the past 2 decades (Deshpande et al., 2008). According to data from the National Health Interview Survey, NHIS, for the period from 1980 to 2005, the age-adjusted prevalence of diagnosed diabetes was fairly stable at about 3.0% from 1980 to 1990 and then begun to increase (Deshpande et al., 2008). In 1990, the age-adjusted prevalence rate was 2.9% (Deshpande et al., 2008). It increased to 4.5% in 2000 and to 5.3% in 2005 (Deshpande et al., 2008). The overall prevalence of diagnosed diabetes increases with age and the rate of increase overtime has been longest in people over 65 years of age (Deshpande et al., 2008). The prevalence of self-reported diagnosed diabetes has increased over time from 1997 to 2005 in all age groups (Deshpande et al., 2008).

Prediabetes is a precursor condition to diabetes where people can have impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) or both.From 1988 to 1994, approximately 25% of a cross-sectional sample of U.S. adults 40 to 74 years of age were classified as having prediabetes (Deshpande et al., 2008). For the year 2000, this would mean that 12 million people in the United States had prediabetes (Deshpande et al., 2008). In 2005 to 2008, based on fasting glucose or A1c levels, 35% of U.S adults aged 20 years or older had prediabetes (50% of those aged 65 years or older) (CDC, 2011). Applying this percentage to the entire U.S. population in 2010 yields an estimated 79 million Americans, aged 20 years or older, with prediabetes (CDC, 2011). On the basis of fasting glucose or A1c levels, and after adjusting for population age differences, the percentage of U.S. adults aged 20 years or older with prediabetes in 2005 to 2008 was similar for non-Hispanic whites (35%), non-Hispanic blacks (35%), and Mexican Americans (36%) (CDC, 2011).According to the IDF Diabetes Atlas, currently, the number of cases of impaired glucose tolerance (2010) worldwide is estimated to be approximately 340 million (Rhee & Woo, 2011). North America has the highest prevalence of impaired glucose tolerance in the world, with 10.4% (Rhee et al., 2011). For Europe and the Middle East, the values are 8.9% and 8.2% respectively (Rhee et al., 2011). There is also a predicted increase in the prevalence of pre diabetes world wide. It is found that by 2030, the global prevalence of impaired glucose tolerance is estimated to reach 8.4%, which will be approximately 456 million people (Rhee et al., 2011).

2b. Risk Factors for Prediabetes and Diabetes

The biology and pathogenesis of diabetes is complex and a number of modifiable and nonmodifiable risk factors increase the risk for diabetes. Risk factors for type 1 diabetes include family history, race and certain viral infections during childhood (Deshpande et al., 2008). Risk factors for type 2 diabetes are more diverse where some are modifiable and others are not. Nonmodifiable risk factors for type 2 diabetes include age, gender, ethnicity, family history, history of gestational diabetes and low birth weight (Deshpande et al., 2008). Modifiable or lifestyle risk factors include BMI, physical inactivity, poor nutrition, hypertension, smoking, alcohol use, education, total cholesterol, LDL, HDL, and triglyceride levels (Deshpande et al., 2008). This study examines the following risk factors: age, gender, education, annual family income, BMI, hypertension, mean systolic blood pressure, mean diastolic blood pressure, total cholesterol, LDL, HDL, and triglycerides.

a. Age

The age of an individual is one risk factor for pre diabetes and type 2 diabetes. It is found that diabetes incidence and prevalence increases with age (Deshpande et al., 2008). In 2005, the Centers for Disease Control reported that the prevalence of diabetes among people aged 20 years or older was 20.6 million (9.6% of the people in that age group), and the prevalence of diabetes increased with age (10.3 million people aged 60 years or older, or 20.9% of those in that age group, had diabetes.) (Deshpande et al., 2008). Rhee et al. also found that even in NHANES subjects, the prevalence of IFG and IGT increase proportionally with age (2011). In a study by Cowie et al. the prevalence of IFG, IGT and total pre diabetes, crude prevalence of either IFG or IGT, according to age was observed (2009). The results of the study indicated that in individuals over the age of

20 years, 25.7% had IFG (Cowie et al., 2009). IFG also increased with age, doubling between ages 20-39 and 40-59 years (Cowie et al., 2009). For individuals over the age of 60 years, the IFG levels remained constant (Cowie et al., 2009). IGT was found in 13.8% of those aged over 20 years which was about half the prevalence of IFG (Cowie et al., 2009). The prevalence steadily increased with age, peaking at 35.1% in those aged 75 years and above (Cowie et al., 2009). The total pre diabetes which is estimated by either IFG or IGT was about 30% among people 20 years and above (Cowie et al., 2009). The prevalence also increased with age, peaking at 75 years and above (Cowie et al., 2009). In another study by Harris et al. the prevalence of impaired fasting glucose increased from ages 20 to 39 years to age 60 to 74 years or ages above 75 years (1998).

b. Ethnicity

The United States consists of a vast number of ethnic minorities and other population sub groups. Based on the 2000 Census data, ethnic minorities constitute approximately 25% of the overall population of the U.S (Dagogo-Jack, 2003). In addition, the population of minority groups has been increasing at a faster rate than the general U.S. population (Dagogo-Jack, 2003). Although the growth of these minority populations is a sign of diversity, minority ethnic groups suffer disproportionately from type 2 diabetes, pre diabetes and their long-term complications. There is no finding as to why ethnic disparities exist in the occurrence of diabetes however, genetic, environmental and lifestyle factors may likely account for the increased prevalence of type 2 diabetes among ethnic minorities (Dagogo-Jack, 2003). Furthermore, the increase in morbidity and mortality from diabetes may be the result of socioeconomic factors (Dagogo-Jack, 2003).

Diabetes-related mortality is higher for minorities than for white persons, and the rate is increasing (Carter et al., 1996). It is found that African Americans and other ethnic minority groups suffer disproportionately from type 2 diabetes and its complications than do white Americans (Deshpande et al. 2008). Age-adjusted prevalence rates for diagnosed diabetes have been higher among African Americans and Hispanics compared with whites (Deshpande et al., 2008). African American women have the highest prevalence of diabetes compared with other racial or ethnic and gender groups (Deshpande et al., 2008). In 2005, the age-adjusted prevalence rate for diagnosed diabetes was 8.3% in African American women compared with 8 % in African American men, 7.5% in Hispanic women, 7.1% in Hispanic men, 4.7% in white women and 5.4% in white men (Deshpande et al., 2008). Estimates show that 3.2 million African Americans currently have diabetes and the number of African Americans with diabetes is projected to triple by the year 2050, while the number of whites with diabetes is estimated to only double (Deshpande et al. 2008).

The American Diabetes Association (ADA) states that type 2 diabetes is more common in African Americans, Latinos, Native Americans, Asian Americans, Native Hawaiians and other Pacific Islanders (ADA, 2011). In addition, after adjusting for population age differences, 2007-2009 national survey data for people diagnosed with diabetes found the following prevalence by race ethnicity for those 20 years or older: 7.1% of non-Hispanic whites, 8.4% of Asian Americans, 12.6% of non-Hispanic blacks and 11.8% of Hispanics (ADA, 2011). Among Hispanics the rates were: 7.6% for Cubans, 13.3% for Mexican Americans and 13.8% for Puerto Ricans (ADA, 2011).

The 1976-1980 National Health and Nutrition Examination Survey (NHANES II) found the total prevalence of diabetes in blacks persons (diagnosed and undiagnosed) to be 1.5 times greater than that of white persons (Carter et al., 1996). The NHIS also confirms this increased risk for black persons even after controlling for an increased prevalence of obesity (Carter et al., 1996). All Hispanic population subgroups studied to date have a greater prevalence of diabetes than do white persons (Carter et al., 1996). For example, data from the 1982-1984 Hispanic Health and Nutrition Examination Survey (HHANES) show that, among Hispanic persons living in the United States, the prevalence of non-insulin dependent diabetes is greatest for Puerto Ricans and Hispanic persons living in the southwest while it is lowest for Cubans (Carter et al., 1996). The excess of diabetes in the Mexican-American population persists even when the greater overall and centralized obesity rates of the Mexican American population are compared with those of white persons (Carter et al., 1996).

According to the 1990 census, Native Americans comprise more than 500 tribal organizations and about 1.9 million persons identified themselves as an American Indian or Alaska native (Carter et al., 1996). High prevalences of diabetes among most Native American tribes have been reported (Carter et al., 1996). For example, the Pima tribe in Arizona has one of the highest rates of diabetes in the world (Carter et al., 1996).

The Seattle Japanese-American Community Diabetes Study also found that Asian Americans and Pacific Islander Americans had a higher prevalence of diabetes than that reported for the U.S. white population (Carter et al., 1996). Carter et al. reported that Filipinos had the highest prevalence of diabetes among the four largest ethnic Asian groups in Hawaii (Chinese, Filipino, Japanese, and Korean) (1996). In addition, all groups had higher prevalences than those of white persons (Carter et al., 1996). Few incidence studies on diabetes have been done thus far however, incidence rates in the United States have been found to be higher in black persons, Mexican Americans, the Pima tribe and Japanese Americans compared to white individuals (Carter et al., 1996).

c. Gender

The prevalence of prediabetes and diabetes according to gender has been contradictory. Some studies have found that women suffer more disproportionately from diabetes while others have found men to have a slightly higher prevalence. For example, Moore et al. (2003) stated that the prevalence of diabetes in adults is slightly higher in women and increases significantly with age. Another study which used the 2002 and 2004 core interviews of the U.S. nationally representative Health Retirement Study (HRS) and the 2003 HRS diabetes-specific mail survey had found that women had significantly higher HbA1c levels, blood pressure, body mass index and more frequent occurrence of early complications than men (Chiu & Wray, 2011). In addition, this study also found that women reported significantly less frequent exercise behavior and had lower scores than did men on diabetes coping status, perceived control, self efficacy, and perceived family support, but higher scores on depressive symptoms, compared to men (Chiu & Wray, 2011).

In contrast, results from a Canadian study, that used the 1996 to 1997 National Population Health Survey, indicated that males in almost all age groups, had a higher prevalence of diabetes than females (Choi & Shi, 2001). The only exception was in the 35 to 44 age group, in which males had a slightly lower prevalence (1.1%) than females

(1.5%) (Choi et al., 2001). The overall odds ratio for diabetes was 1.44 comparing males with females, after adjusting for a number of potential confounders (Choi et al., 2001). In regards to gender, while this study found a higher proportion of males (54% males, 46% females) among Canadian patients with diabetes, studies in the United States found a higher proportion of females (42% males, 58% females) with diabetes (Choi et al., 2001).

Another study evaluated the prevalence and time trends for diagnosed and undiagnosed diabetes, impaired fasting glucose and impaired glucose tolerance in U.S. adults based on the Third National Health and Nutrition Examination Survey, 1988-1994 (NHANES III) (Harris, Flegal, Cowie, Eberhardt, Goldstein, Little, Wiedmeyer & Byrd-Holt, 1998). It was found that for the total prevalence of diabetes, prevalence was similar for men and women in each age group (Harris et al., 1998). However, the prevalence of impaired fasting glucose was higher for men than for women in each racial or ethnic group, and the age standardized rate in men versus women was 1.8 for all races combined (Harris et al., 1998). Lastly, the total prevalence of diabetes and impaired fasting glucose combined was estimated to be 15.6 million for men and only 13.4 million for women (Harris et al., 1998).

d. Education as Socioeconomic Status

The prevalence of type 2 diabetes varies with socioeconomic status (SES) within different populations. SES is a complex construct and most often different variables such as education, income, and occupation, that are used to measure it, can reflect different specific exposures (Robbins, Vaccarino, Zhang & Kasl, 2001). Many studies have found an inverse relationship between education and diabetes prevalence. For example, in the

United States, intragroup comparisons among white persons, black persons, Hispanic persons, and Japanese Americans show an association between lower socioeconomic status or education level and higher prevalence of diabetes (Carter et al., 1996). This finding is due to the fact that large proportions of black and Hispanic populations live in poverty and have less than a high school education (Carter et al., 1996). Therefore, socioeconomic status may strongly influence the prevalence of diabetes in these minority groups (Carter et al., 1996).

Robbins and colleagues examined the association of diabetes with different measures of SES, education as one of them, within each of 4 strata-African American women, non-Hispanic White women, African American men and non-Hispanic white men (2001). The study found that education was a significant predictor of diabetes prevalence among African American women and that education was also inversely associated with diabetes prevalence among non-Hispanic white women in particular for the group with more than 12 years of education (Robbins et al., 2001). However, education had a weak inverse gradient with diabetes prevalence among non-Hispanic white men with an odds ratio for those with more than 12 years of education of 0.60 relative to those with less than 9 years of education (Robbins et al., 2001). Similarly, education did not yield significant associations with diabetes in African American men (Robbins et al., 2001). The analyses from this study provide strong, consistent evidence that SES, measured by education, income and occupation, is inversely associated with type 2 diabetes in both African American and non-Hispanic white women (Robbins et al., 2001). However, they do not provide such evidence for African American or non-Hispanic white men (Robbins et al., 2001).

Another study determined and quantified socioeconomic position (SEP), a similar measure to SES, inequalities in diabetes in different areas of Europe for men and women. Similar to the previous mentioned study, it was found that low SEP was related to a higher prevalence of diabetes (Espelt, Borrell, Roskam, Rodriguez-Sanz, Stirbu, Dalmau-Bueno, Regidor, Bopp, Martikainen, Leinsalu, Artnik, Rychtarikova, Kalediene, Dzurova, Mackenbach & Kunst, 2008). For example, men who attained a level of education equivalent to lower secondary school or less had a prevalence ratio of 1.6 compared with those who attained tertiary level education, whereas the corresponding value in women was 2.2 (Espelt et al., 2008). In addition, one study found that people with less than primary education have 2.69 higher risk of having diabetes than those with primary education or more (Espelt, Goda, Franch&Borrell, 2011).

Furthermore, there is an inverse relationship between SEP, morbidity and mortality. For example, Saydah and collegues examined disparities in diabetes-related mortality for socioeconomic status groups in nationally representative U.S. samples (2010). Results indicated that having less than a high school education was associated with a twofold higher mortality from diabetes after controlling for age, gender, race/ethnicity, marital status, and body mass index compared with adults with a college degree or higher education level (Saydah & Lochner, 2010). In addition, the risk of diabetes-related death demonstrated a clear gradient from lowest to highest education level (Saydah et al., 2010). A study by Sims et al. found that the lack of awareness of diabetes was associated with low education and low occupation in women but not in men and that the lack of treatment was also associated with low education in women (2011).

e. Income as SES

Income is another measure that researchers use to measure SES and its constituent elements which are accepted as being determinants of health. Income is not only a direct measure of economic resources but also a primary determinant of social prestige and status in the United States. There is considerable evidence to show that low income is associated with shorter life expectancies and increased mortality (Rabi et al., 2006). Research has also found that diabetes may be up to two times more prevalent in low income populations compared to wealthy populations (Rabi et al., 2006). One study examined the socioeconomic gradient in diabetes prevalence, awareness, treatment, and control among African Americans and found that in adjusted models, low-income men and women had greater probabilities of diabetes than high income men and women (Sims, Diez Roux, Boykin, Sarpong, Gebreab, Wyatt, Hickson, Payton, Ekunwe & Taylor, 2011). Associations of low income with diabetes prevalence persisted and remained statistically significant after risk factor adjustment in both men and women (Sims et al., 2011). In addition, women had a higher prevalence of diabetes than men (19.6% vs. 15.9%), but greater awareness (90% vs. 88.2%), treatment (86.8% vs. 84.4%), and control (39.2% vs. 35.8%) (Sims et al., 2011).

Another study that examined socioeconomic status and diagnosed diabetes incidence, found that among women, diabetes incidence was inversely associated with income (Robbins, Vaccarino, Zhang & Kasl, 2005). Among men, a trend toward lower diabetes incidence with higher income and higher education was evident (Robbins et al., 2005). This inverse association between income and diabetes risk is complex. However, it has been speculated that the increased diabetes risk seen in low income groups is related to the increased prevalence of obesity within this group (Rabi et al., 2006).

A Canadian study by Rabi et al. was conducted to determine whether income is associated with referral to a diabetes center within a universal health care system (2006). Results indicated that low income is associated with a higher prevalence of diabetes and a higher population rate of referral (Rabi et al., 2006) In regard to access to diabetes care, it is found that individuals from lower socio-economic groups have impaired access to care reflected in longer wait times and fewer referrals for specialist care (Rabi et al., 2006). This contributes to the observation of worse health outcomes such as the increased rate of acute diabetic complications. The impaired access to care may also affect one's engagement in diabetes risk reduction behaviors. Rabi et al. suggest that neighborhood and community level factors contribute to the increased diabetes risk seen in low income populations (2006). For example, the "built" environment has been shown to be a clear barrier to physical activity in poorer neighborhoods (Rabi et al., 2006). In addition, low income communities have been shown to have less biomass and park-space compared to wealthier communities (Rabi et al., 2006). There may also be a perception that it is less safe to walk in a poorer neighborhood which deters not only physical activity but erodes the sense of community among residents (Rabi et al., 2006). Robbins and colleagues suggest that while most clinicians who treat patients with diabetes in the United States are aware that type 2 diabetes occurs more frequently among racial and ethnic minorities, many are not aware that it is also more likely to appear among patients with low SES, regardless of race or ethnicity (2005). Findings of this study state that effective, population-based interventions to decrease obesity and improve health behaviors may reduce, but not eliminate, SES disparities in diabetes incidence (Robbins et al., 2005).

f. Body Mass Index, BMI

Obesity is defined medically as a state of increased adipose tissue of sufficient magnitude that may result in adverse health consequences. (Gómez-Ambrosi, Silva, Galofré, Escalada, Santos, Gil, Valentí, Rotellar, Ramírez, Salvador &Frühbeck, 2011). Therefore, obesity is a major modifiable risk factor for type 2 diabetes and many other diseases (Choi et al., 2001). BMI has been traditionally used as a surrogate measure of adiposity and is the most frequently used diagnostic tool in the current classification system for obesity (Gómez-Ambrosi et al., 2011). Many studies have shown consistent results that the prevalence of diabetes increases with obesity (BMI) in both males and females. Choi et al. found a differential effect of obesity on the prevalence of diabetes in males and females (2001). For males, the prevalence of diabetes started to increase when BMI reached 27 (overweight category) but for females the prevalence of diabetes started to increase at a lower BMI level of 25 (Choi et al., 2001). This is consistent with other studies, which have shown that the per unit increase in BMI had a larger effect on the risk of diabetes among women than men. However, results of this study also indicate the need to use different criteria to define obesity for women and men. Men on average have a larger body build than women and therefore obesity should be defined differently based on BMI (Choe et al., 2001).

Another study determined whether the associations of BMI and fat distribution with diabetes risk are modified by race. Previous research on the prevalence and incidence of type 2 diabetes in the U.S. has consistently shown the frequency of diabetes to be higher among black than among white Americans and to be higher among obese individuals and those with centralized fat distribution (Resnick, Valsania, Halter & Lin, 1998). Research has also found higher BMI and subscapular-to-triceps skinfold ratio

(STR) among blacks and showed that blacks were at a substantially higher 16-year risk of developing diabetes than whites (Resnicketal., 1998). Resnick et al. discovered that the age-adjusted cumulative incidence of diabetes was greater with increasing BMI in all race-sex groups (1998). For example, blacks were at higher risk of diabetes at all levels of BMI compared with whites. However, at lower BMI, the relative risk of diabetes for black: white subjects was much larger than at higher levels of BMI (Resnick et al., 1998).

Studies have also focused on modifying an individual's BMI and weight to prevent and reduce the risk for diabetes. For example, a study by the Diabetes Prevention Program identified individuals who were at risk for developing diabetes due to elevated fasting plasma glucose or impaired glucose tolerance levels that were not yet in the diagnostic range, in order to determine if the medication metformin or an intensive lifestyle intervention, which consists of a goal of 7% weight loss and 150 min/wk of moderate physical activity, could delay or prevent the onset of diabetes (Crandall, Knowler, Kahn, Marrero, Bray, Haffner, Hoskin& Nathan, 2008). Results indicated that fifty percent of the lifestyle-intervention group lost 7% of their body weight and that the 3-year incidence of diabetes in the metformin group was 31% lower than that in the placebo group (Crandall et al., 2008). In addition, the incidence of diabetes was 58% lower in the lifestyle group than in the placebo group (Crandall et al., 2008). Weight loss was the predominant predictor of reduced diabetes incidence, with a 16% reduction in risk per kilogram of weight lost (Crandall et al., 2008). The effectiveness of the Diabetes Prevention Program lifestyle intervention was similar in all ethnic groups and both sexes and was greatest in older participants (Crandall et al., 2008).

g. Blood Pressure and Hypertension

The incidence of type 2 diabetes is increasing rapidly and research has shown a close relationship between hypertension and type 2 diabetes. Despite this close relationship, little information exists on the relationship of blood pressure levels with the subsequent development of type 2 diabetes (Conen, Ridker, Mora, Buring & Glynn, 2007). In addition, few studies have analyzed the precise relationship between blood pressure and incident type 2 diabetes. Gress et al. found that individuals with hypertension had a relative risk of 2.34 (95% confidence interval 2.16-2.73) of developing type 2 diabetes compared with individuals without hypertension (2000). However, no multivariable adjustment of this association was performed in their study (Conen et al., 2007). Recently, hypertension has further emerged as a potential risk factor based on several longitudinal studies' findings that higher blood pressure is associated with increased risk of diabetes (Wei, Coady, Goff, Brancati, Levy, Selvin, Vasan& Fox, 2011). However, it still remains unclear whether hypertension is associated with diabetes above and beyond other known risk factors such as age, race, and adiposity (Wei et al., 2011).

Wei et al. examined the association between high blood pressure and incident type 2 diabetes in African Americans and whites aged 35 to 54 years at baseline (2011). Results indicated that 14.6% of African Americans and 7.9% of whites developed diabetes and that the age-adjusted incidence was increasingly higher across increasing blood pressure groups, with the incidence lowest in the normal blood pressure group and highest in the hypertension group (Wei et al., 2011). In addition, after adjustment for age, sex, BMI, fasting glucose, HDL cholesterol and triglycerides, prehypertension or hypertension (compared with normal blood pressure) was associated with greater risks of diabetes in whites, but not African Americans (Wei et al., 2011). Hazard ratios for developing diabetes among normotensive, prehypertensive, and hypertensive African Americans versus normotensive whites were 2.75, 2.28, and 2.36 respectively (Wei et al., 2011). Wei et al. also suggested that in African Americans the higher incidence of diabetes among hypertensive individuals may be explained by concomitantly greater adiposity and other cardiometabolic risk factors (2011). In whites, the association of both prehypertension and hypertension with incident diabetes is partially explained by these and other risk factors. However, regardless of baseline blood pressure status, research has found that African Americans have a greater risk of developing diabetes than whites (Wei et al., 2011).

Furthermore, Conen et al. conducted a prospective cohort study and examined the relationship of blood pressure and blood pressure progression with the subsequent development of type 2 diabetes in women (2007). Results showed that the baseline blood pressure and blood pressure progression are strong and independent predictors of incident type 2 diabetes among initially healthy women (Conen et al., 2007). During the median follow-up of 10.2 years, 1672 out of 38172 women developed type 2 diabetes (Conen et al., 2007). After 10 years of follow up, 1.4, 2.9, 5.7, and 9.4% of women across the four baseline blood pressure categories developed type 2 diabetes (Conen et al., 2007). In addition, women with baseline hypertension had a seven-fold increased risk of developing diabetes compared with women with optimal blood pressure (Conen et al., 2007). Even after multivariable adjustment, these risk factors were attenuated but remained statistically significant (Conen et al., 2007). Thus, there was still a three-fold increased risk for type 2 diabetes among women with hypertension compared with women with optimal blood pressure (Conen et al., 2007). Lastly, women progressing to hypertension had a 64% increased risk of incident diabetes, and this risk more than doubled in those with baseline hypertension (Conen et al., 2007).

h. Cholesterol, HDL and LDL

Persons with type 2 diabetes feature important modification of both low density lipoprotein, LDL, and high density lipoprotein particles (Krauss, 2004). Insulin resistance and type 2 diabetes are associated with a clustering of interrelated plasma lipid and lipoprotein abnormalities, which include reduced HDL cholesterol, a predominance of small dense LDL particles, and elevated triglyceride levels (Krauss, 2004). It is found that these abnormalities occur in many patients despite normal LDL cholesterol levels (Krauss, 2004). Lipid modification is also a feature of the insulin resistance syndrome, which underlies many cases of type 2 diabetes (Krauss, 2004). In fact, pre-diabetic individuals often exhibit an atherogenic pattern of risk factors that includes higher levels of total cholesterol, LDL cholesterol, and triglycerides and lower levels of HDL cholesterol than non diabetic individuals (Krauss, 2004). Although the plasma LDL cholesterol level is usually normal in type 2 diabetic patients, metabolism of LDL is significantly modified (Krauss, 2004). The increased production of precursors of small dense LDL particles results from the increased hepatic production and/or retarded clearance from plasma of large VLDL (Krauss, 2004). Plasma VLDL levels correlate with increased density and decreased size of LDL which in turn is inversely related to plasma levels of HDL (Krauss, 2004). It is found that small dense LDL particles appear to arise from the intravascular processing of specific larger VLDL precursors through a series of steps, including lipolysis (Krauss, 2004). Further triglyceride enrichment of the lipolytic products through the action of cholesteryl ester transfer protein, together with hydrolysis of triglyceride and phospholipids by hepatic lipase, leads to increased production of small dense LDL particles (Krauss, 2004). The reductions in HDL associated with type 2 diabetes and insulin resistance are multifactorial, but a major factor appears to be increased transfer of cholesterol from HDL to triglyceride-rich lipoproteins, with reciprocal transfer of triglyceride to HDL (Krauss, 2004). Triglyceride-rich HDL particles are hydrolyzed by hepatic lipase and, as a result are rapidly catabolized and cleared from plasma (Krauss, 2004). The combination of increased production and decreased catabolism of triglyceride-rich lipoproteins accentuates hypertriglyceridemia (Kreisberg, 1998). Hypertriglyceridemia changes the composition of all lipoproteins, enriches them with triglycerides, and makes them better substrates for hepatic lipase, which leads to decreased levels of HDL cholesterol and increased production of LDL cholesterol (Kreisberg, 1998). Therefore, as triglycerides increase within the “normal range”, abnormalities in HDL and LDL become more apparent. Krauss also found that behavioral interventions such as diet and exercise can improve diabetic dyslipidemia however, for most patients, pharmacological therapy is needed to reach treatment goals (2004). In addition, there are several classes of medications that can be used to treat lipid and lipoprotein abnormalities associated with insulin resistance and type 2 diabetes. Epidemiologic and intervention studies have shown significant improvement in the features of diabetic dyslipidemia with medical nutrition therapy and physical activity (Krauss, 2004).

i. Triglycerides

Lipid abnormalities in patients with type 2 diabetes are likely to play an important role in the development atherogenesis. These lipid disorders include not only quantitative but also qualitative abnormalities of lipoproteins (Vergés, 2005). It is found that plasma triglyceride level is frequently increased in type 2 diabetes which is due to an augmented number of VLDL and IDL particles (Vergés, 2005). In addition, research has shown that reducing excess triglycerides in the blood can lower you chance of developing diabetes as well as heart disease and other problems (MSN, 2011). In a 10 year study of otherwise healthy men, researchers found that those with the lowest triglyceride levels were least likely to develop diabetes (MSN, 2011). In addition, men with high triglycerides who lowered them with healthy lifestyle changes had a diabetes risk that was similar to those who never had a triglyceride problem at all. The results of this study were true even when controlling for diabetes risk factors such as blood pressure, physical activity, body mass index, family history and more (MSN, 2011). Lastly, researchers don't fully understand the relationship between triglycerides and diabetes. However, they believe that excess triglycerides can increase insulin resistance in some people (MSN, 2011).

CHAPTER III

METHODOLOGY

3a. Data Source and Study Population

The data for this study came from the 2007-2008 National Health and Nutrition Examination Survey, 2007-2008 NHANES. This data source is provided by the National Center for Health Statistics, NCHS, and is an annual representative survey of the U.S. civilian non-institutionalized population. The NHANES program began in the early 1960s and since then has been conducted as a series of surveys focusing on different population groups or health topics (CDC, 2009). NHANES assesses the health and nutritional status of adults and children in the U.S. (CDC, 2009). This survey is unique in that it combines interviews and physical examinations. Survey participants are interviewed at home and are invited to a mobile examination center to undergo various examinations and laboratory measurements (Geiss et al., 2010). The survey examines a nationally representative sample of about 5,000 persons each year in which these persons are located in various counties across the country (CDC, 2009). The interview portion of this survey consists of demographic, socioeconomic, dietary, and health-related questions, while the examination component includes medical, dental, and physiological measurements (CDC, 2009). Furthermore, this is the only national survey that reports and captures information about diabetes and prediabetes from an interview as well as laboratory measurements such as FPG, IGT and glycalated hemoglobin level. An informed consent is obtained from each participant for the interview as well as the laboratory examination (CDC, 2009). Findings from NHANES are used to determine the prevalence of major diseases, such as diabetes, and risk factors for these diseases. Risk factors, those aspects of a person's lifestyle, constitution, heredity, or environment that may increase the chances of developing a certain disease or condition are also examined (CDC, 2009). In addition, the survey sample is selected in order to represent the U.S. population of all ages. To produce reliable statistics, NHANES over-samples persons 60 years in age and older, African Americans and Hispanics (CDC, 2009). All participants of the survey visit the physician and have body measurements, laboratory examination, and dietary interviews. Since the U.S. population has been experiencing a dramatic growth in the number of older people, particular attention and extensive examination is performed for this population in question (CDC, 2009). NHANES information and data are made available to data users and researchers around the world through the internet and on easy-to-use CD-ROMs (CDC, 2009). Therefore, research organizations, universities, health care providers and educators benefit from using this data source. In addition, results from NHANES benefit people in the United States in important ways. For example, facts about the distribution of health problems and risk factors in the population provide researchers important clues to the causes of disease (CDC, 2009).

For this study, data from the 2007-2008 NHANES diabetes questionnaire, laboratory, examination and demographic files were used. The demographic file provides family-level and individual-level information. All survey participants who have a household interview record have a demographics file record (CDC, 2009). The demographic file also includes the household interview and examination status codes, interview and examination sample weights, languages of interview for the household and examination interviews, information about household reference person, proxy respondent codes and demographic variables about the survey participant (CDC, 2009). Persons 16 years of age and older and emancipated minors were interviewed directly and a household interview was conducted in-person with an interviewer (CDC, 2009). In this study the following demographic variables were used: age, gender, ethnicity, education and annual family income. The examination variables included in this study were diastolic blood pressure, systolic blood pressure and body mass index. Laboratory variables that were used in this study included HDL, LDL, triglycerides and total cholesterol. The laboratory data also contains measures such as the OGTT and fasting blood glucose levels, FPG. This helped identifying those individuals that had undiagnosed diabetes. Standard diagnostic criteria were used to determine whether an individual had undiagnosed diabetes based on OGTT and FPG values. If an individual had an OGTT greater than 200 and FPG greater than 126 than the individual was excluded from the study. These laboratory values were the recommended values from the American Diabetes Association (2011).

3b. Eligibility Criteria

The diabetes questionnaire was used to determine those that are aware of their risk for diabetes (prediabetes), those that have diabetes and those individuals that are engaging in diabetes risk reduction behaviors. The questions asked to determine if an individual is at risk for diabetes was *ever told you have prediabetes* and *ever told have health risk for diabetes*. A new variable was than created called awareness of diabetes risk which included both of the questions *ever told you have prediabetes* or *ever told* *have health risk for diabetes* and was the main independent variable in the study. Only those individuals aware of their risk for diabetes were included in this study. The question asked to determine if an individual has diabetes was *doctor told has diabetes*. If the individual was diagnosed with diabetes, than they were excluded from the study. Questions that determined if an individual was reducing their risk for diabetes were *are you controlling weight*, *are you increasing physical activity*, *are you reducing fat/calories in diet*, *past year told control weight*, *past year told increase physical activity* and *past year told to reduce fat/calories in diet.* A new variable called diabetes risk reduction behavior was than created from the ongoing risk behavior questions: *are you controlling weight*, *are you increasing physical activity* and *are you reducing fat/calories in diet* and was the main dependent variable of the study. The total sample before exclusions were made was 10149. However, after the exclusions according to the criteria mentioned, the total sample of NHANES respondents that met the study eligibility criteria was 4083.The 4083 participants included in this study were also aged 20 years and above and were non-Hispanic black, non-Hispanic white and Mexican American in ethnicity. In addition, males and females of the total sample were examined separately. It was found that 2007 (49.2%) of the study respondents were males and 2076 (50.8%) were females.

3c. Independent Variables

The independent variables were obtained from the demographic, examination, laboratory and questionnaire files. These included age, ethnicity, education, annual family income, BMI, hypertension, mean systolic blood pressure, mean diastolic blood pressure, total cholesterol, LDL, HDL, and triglycerides.Any participant that did not have complete information on the demographic, laboratory, examination and questionnaire component of the survey was eliminated from the study.

Aware of Diabetes Risk:

This variable was created from the questions: *ever told you have prediabetes* and *ever told have health risk for diabetes.* This was the main independent variable.

Diabetes Risk Reduction Behavior:

This variable was created from the ongoing diabetes risk reduction behavior questions which include: *are you controlling weight*, *are you increasing physical activity* and *are you reducing fat/calories in diet*. This was the dependent variable.

Age:

Age was reported as a whole number in years at time of screening. Only those individuals 20 years and above were included in this study.

Gender:

Gender of the participant was reported as either male or female and coded as 0 for male and 1 for female.

Ethnicity:

Ethnicity was categorized into three groups: non-Hispanic whites, non-Hispanic blacks and Mexican Americans.

Education:

The education variable is the highest grade or level of education completed by adults 20 years and older (CDC, 2009). The response categories are: less than 9th grade education, 9-11th grade education (includes 12th grade and no diploma), High school graduate /GED, some college or associates (AA) degree, and college graduate or higher (CDC, 2009). Education level was self-reported and categorized into 3 groups: less than high school, high school, and college.

Annual Family Income:

This variable is the total family income variable and is released as an income range value. The income section of the household interview includes several questions about sources of income including wages, retirement income, disability payments, interest income, and assistance programs, but the amounts of income from each of the income sources were not obtained (CDC, 2009). The respondent was asked to report total family income for themselves and the other members of their family in dollars (CDC, 2009). Annual Family income was categorized into three groups: less than $20,000, $20,000-$74,999 and $75,000 and above.

BMI:

Body mass index was reported as kg/m^2. BMI was categorized into three groups: less than 25 as “normal”, 25 to 29.999 as “overweight” and greater than or equal to 30 as “obese”.

Hypertension:

The hypertension variable was created from questions of the blood pressure questionnaire and mean systolic and diastolic blood pressure readings. Questions included: *taking prescription for hypertension*, *told have prehypertension* and *borderline hypertension*. If the survey participant also had a mean systolic blood pressure reading greater than 140 or a mean diastolic blood pressure reading greater than 90 than they were considered to have hypertension. Recommendations for the blood pressure readings came from the American Heart Association (2011).

Mean Systolic Blood Pressure:

The systolic blood pressure readings came from the examination portion of the survey. The survey participant would rest quietly in a sitting position for 5 minutes determining the maximum inflation level (CDC, 2009). Three consecutive systolic blood pressure readings were taken to obtain an accurate blood pressure. Systolic blood pressure readings were reported in mm Hg. A mean systolic blood pressure reading was computed from the three readings. All blood pressure determinations were taken in the mobile examination center.

Mean Diastolic Blood Pressure:

The diastolic blood pressure readings also came from the examination portion of the survey. The survey participant would rest quietly in a sitting position for 5 minutes determining the maximum inflation level (CDC, 2009). Three consecutive diastolic blood pressure readings were taken to obtain an accurate blood pressure. Diastolic blood pressure readings were reported in mm Hg. A mean diastolic blood pressure reading was computed from the three readings. All blood pressure determinations were taken in the mobile examination center.

Total Cholesterol:

Total cholesterol was measured in serum using the Roche Modular P Chemistry analyzer (CDC, 2009). In this enzymatic method, esterified cholesterol is converted to cholesterol by cholesterol esterase (CDC, 2009). The resulting cholesterol is then acted upon by cholesterol oxidase to produce cholest-4-en-3-one and hydrogen peroxide (CDC, 2009). The hydrogen peroxide then reacts with 4-aminophenazone in the presence of peroxidase to produce a colored product that is measured at 505 nm (secondary wavelength = 700 nm) (CDC, 2009). The final step is known as the Trinder reaction which is a single reagent, endpoint reaction that is specific for cholesterol. Total cholesterol was reported in mg/dL.

LDL:

Serum LDL-cholesterol levels were derived on examinees that were examined in the morning session only. LDL is calculated from measured values of total cholesterol, triglycerides and HDL cholesterol according to the Friedewald calculation:

[LDL-cholesterol] = [total cholesterol] – [HDL-cholesterol] – [triglycerides/5] where all values are expressed in mg/dL.

HDL:

For the HDL method, a magnesium/dextran sulfate solution is first added to the specimen to form water-soluble complexes with non-HDL cholesterol fractions. These complexes are not reactive with the measuring reagents added in the second step. With addition of reagent 2, HDL-cholesterol esters are converted to HDL-cholesterol by PEG-cholesterol esterase. The HDL-cholesterol is acted upon by PEG-cholesterol oxidase, and the hydrogen peroxide produced from this reaction combines with 4-amino-antipyrine and HSDA under the action of peroxidase to form a purple/blue pigment that is measured photometrically at 600 nm (secondary wavelength = 700 nm). When the cholesterol measuring enzymes are modified with PEG, they are preferentially more reactive with HDL-cholesterol than the other cholesterol fractions. This is an endpoint reaction that is specific for HDL-cholesterol. HDL is reported in mg/dL. This method was from the Centers for Disease Control (2009).

Triglycerides:

Triglycerides were measured in serum using Roche Modular P chemistry analyzer. In this enzymatic method reagent 1 (glycerol blanking) is added first. Free glycerol is converted to glycerol-3-phosphate (G3P) by glycerol kinase. G3P is acted upon by glycerol phosphate oxidase to produce dihydroxyacetone phosphate and hydrogen peroxide. The hydrogen peroxide combines with 4-chlorophenol under the action of peroxidase to produce an oxidation product that that does not react with the colorometric component of reagent 2. After this initial reaction sequence is completed, the Mod P records a blank absorbance reading. Then reagent 2 is added. The second reaction is driven by the reagents from bottle 1, with lipase added in reagent 2 to convert triglycerides to glycerol, and 4-aminophenzone added to react with the hydrogen peroxide produced in the last reaction. The reaction is measured at 505 nm (secondary wavelength = 700 nm). This method is a two-reagent, endpoint reaction that is specific for triglycerides. This method was from the Centers for Disease Control (2009).

3d. Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) version 18 was used to organize and analyze the data in NHANES 2007-2008 and to make it suitable for the study. To achieve sufficient subpopulation representation, NHANES oversampled certain populations (CDC, 2009). For example, NHANES oversampled all Hispanics, not just Mexican Americans (CDC, 2009). In addition, for each of the race/ethnicity domains the 12-15 and 16-19 year age domains were combined and the 40-59 year age minority domains were split into 10 year age domains 40-49 and 50-59. (CDC, 2009).This has led to an increase in the number of participants aged 40+ and a decrease in 12-19 year olds from previous cycles (CDC, 2009). Frequency tables were created using cross tabulation for males and females to determine the representation of categorical variables such as age, education, annual family income, BMI, and hypertension. Chi-square tests were conducted for the categorical variables for pairwise comparisons and to determine differences across groups. In addition, cross tabulation and pairwise comparisons were conducted for the ongoing and past year risk reduction behaviors for males and females. One way ANOVA was conducted for the continuous variables which included age, mean systolic blood pressure, mean diastolic blood pressure, total cholesterol, LDL, HDL and triglycerides. Tukey post hoc tests were produced to determine differences across groups for the continuous variables. Males and females were examined separately for all the variables. Univariate and multiple logistic regression were performed for males and females separately to model diabetes risk reduction behavior among those participants who were aware of their diabetes risk by age, education, annual family income, BMI, hypertension, mean systolic blood pressure, mean diastolic blood pressure, total cholesterol, LDL, HDL, and triglycerides. The odds ratio and the 95% confidence intervals were reported from the univariate and multivariate analysis to determine the strength and level of association between each of the independent variables and the main dependent variable. Throughout all analyses performed, a p-value of 0.05 and a confidence interval of 95% were used to determine statistical significance.

CHAPTER IV

RESULTS

4a. Sample Demographics

The total sample of NHANES respondents that met the eligibility criteria was 4083 out of which 2007 were males and 2076 were female participants. Males and females were examined separately. Percentages were reported for the categorical variables education, annual family income, BMI and hypertension while mean and standard deviations were presented for the continuous variables age, mean systolic blood pressure, mean diastolic blood pressure, total cholesterol, LDL, HDL and triglycerides. P-values at the 95% confidence interval ($P<0.05$) are also presented for each listed continuous and categorical variable to determine statistical significance.

The demographic and biological characteristics of male and female participants are presented in table 1 and table 2 respectively. Over half of the male participants, 56.5%, identified themselves as non-Hispanic whites, while non-Hispanic blacks and Mexican Americans each represented about a quarter of the sample, 23.0% and 20.6%. Females had a similar distribution in which 56% identified themselves as non-Hispanic whites and non-Hispanic blacks and Mexican Americans represented 23.4% and 20.6% of the total sample. For U.S male and female adults, mean age was statistically significantly higher for non-Hispanic whites compared to non-Hispanic blacks and Mexican Americans. Approximately 54% of Non-Hispanic white males and 55.1% of non-Hispanic white females reported having a college level of education which was statistically significantly higher compared to non-Hispanic blacks and Mexican Americans. For annual family income, 78.9% of Non-Hispanic black males and 74.4% of non-Hispanic black females had more than $20,000. Mexican American males were more obese, 33.2%, which was statistically significantly higher than non-Hispanic white and non-Hispanic black males. In contrast, the proportion of non-Hispanic black females classified as obese according to BMI was significantly higher than the proportions for Mexican American and non-Hispanic white females. Non-Hispanic white males had the highest percentage for hypertension, 40.7% , which was statistically significantly higher than Mexican American and non-Hispanic black males. Non-Hispanic black females had the higher percentage for hypertension, 44.7%. The means of systolic blood pressure, diastolic blood pressure and HDL for non-Hispanic black males and females were statistically significantly higher than Mexican American and non-Hispanic white males and females. Mexican American males had the highest means for total cholesterol, LDL and triglycerides. However, LDL for Mexican American males was not statistically significantly higher than non-Hispanic white and black males.Non-Hispanic white females had the highest means for total cholesterol and LDL and were statistically significantly higher than Mexican American and non-Hispanic black females. Lastly, Mexican American females had the highest mean for triglyceride levels, 131.

4b.Diabetes Risk Reduction Behavior Characteristics

Diabetes risk reduction behavior characteristics for U.S. adult males and females are shown in table 3 and 4. Diabetes risk reduction variables include ongoing lifestyle changes such as controlling weight, physical activity and reduction of fat or calories in diet, past year lifestyle changes, and diabetes risk reduction behavior which is a combination of the ongoing lifestyle changes. Percentages (%) and the count number (n) are listed for each of the categorical variables. P-values are reported to determine statistical significance along with 95% confidence intervals.

As shown in tables 3 and 4, non-Hispanic black males and females had the highest percentages (49.9%, 53.8%, 58.4% and 55.3%) for weight control and increasing physical activity and were statistically significantly higher than non-Hispanic white and Mexican Americans. Non-Hispanic black males had the highest percentage of 46.0% for reducing fat or calories in diet. However, it was not statistically significantly higher compared to non-Hispanic white and Mexican American males. Mexican American females had the highest percentage for reducing fat or calories in diet at 56.3% which also was not statistically significantly higher compared to Non-Hispanic white and Non-Hispanic black females.For past year lifestyle changes of weight control and increasing physical activity, non-Hispanic white males had the highest percentages, 18.6% and 23.5%, respectively, but were not statistically significantly higher than non-Hispanic black and Mexican American males. Non-Hispanic black females had the highest percentages (32.2%, 39.6%, 35.9% and 40.2%) for past year weight control, increasing physical activity, reducing fat/calories in diet and diabetes risk reduction behavior. All were statistically significantly higher, except diabetes risk reduction behavior, than non-Hispanic white and Mexican American females. Mexican American males had the highest percentage of 20.8% for reducing fat/calories in diet. However it was not statistically significantly higher compared to non-Hispanic white and black males. Lastly, 31.7% of non-Hispanic black males were engaging in diabetes risk reduction behavior which was statistically significantly higher than Mexican American and non-Hispanic white males.

4c. Univariate Analysis

Univariate analysis was conducted separately for males and females to determine the association between each of the examined independent variables and the adoption of diabetes risk reduction behavior. Results of the univariate analysis are shown in Tables 5 and 6. The magnitude of association between each of the independent variables, which include awareness of diabetes risk, age, education, annual family income, BMI, hypertension, mean systolic blood pressure, mean diastolic blood pressure, total cholesterol, LDL, HDL, and triglycerides, are quantified using the odds ratio from the logistic regression models. The 95% confidence intervals are also shown for each of the listed odds ratio to determine statistical significance.

As shown in table 5, there is an increase in the adoption of diabetes risk reduction behavior for males who are aware of their risk for diabetes. For example, Mexican American males show higher odds for the adoption of diabetes risk reduction behavior compared to non-Hispanic white males and non-Hispanic black males. Females also showed a similar association between the awareness of diabetes risk and adoption of diabetes risk reduction behavior. An increase in age was associated with the adoption of diabetes risk reduction behavior for non-Hispanic white males. However, there was not a statisticallysignificant association for non-Hispanic black males and Mexican American males, non-Hispanic black females, non-Hispanic white females and Mexican American females. An increase in the level of education and annual family income were associated with increased odds of adoption of diabetes risk reduction behavior among non-Hispanic white, non-Hispanic black and Mexican American males and females. An increase in BMI was also associated with increased odds of adoption of diabetes risk reduction behavior for non-Hispanic white males, non-Hispanic white females,non-Hispanic black females and Mexican American males and females . However, non-Hispanic black males showed a slight decrease in odds of adoption of diabetes risk reduction behavior for BMI. In addition, as males and females discovered that they had hypertension there was an increase in odds of adopting diabetes risk reduction behavior. The association of hypertension and adoption of diabetes risk reduction behavior was higher in non-Hispanic white males compared to non-Hispanic black and Mexican American males. In females, non-Hispanic black females demonstrated a stronger association between hypertension and adoption of diabetes risk reduction behavior compared to non-Hispanic white and Mexican American females. Mean systolic blood pressure, mean diastolic blood pressure, total cholesterol, LDL, HDL, and triglycerides were not statistically significantly associated with the adoption of diabetes risk reduction behavior among all three ethnicities for males. Females showed a similar association between mean systolic blood pressure,, total cholesterol, LDL, HDL and triglycerides. However, diastolic blood pressure was associated with an increase in odds of adoption of diabetes risk reduction behavior.

4d. Multivariate Analysis

Multivariate logistic regression was performed to determine whether the associations in the univariate model were not dependent of other covariates. Table 7,8 and 9 show the multivariate analyses for both males and females. Table 7 included ethnicity and gender in the analyses to determine whether they were significantly associated with diabetes risk reduction behavior. As a result, both of the variables, ethnicity and gender, were significant, which allowed for further stratification according to those variables. Awareness of diabetes risk, education, annual family income and BMI were also statistically significantly associated with diabetes risk reduction behavior while adjusting for other variables. Age, hypertension, mean systolic blood pressure, mean diastolic blood pressure, total cholesterol, LDL, HDL and triglycerides did not show statistical significance and did not have an increase in odds of association with diabetes risk reduction behavior. Table 8 and 9 further stratifies table 7 and shows the break down of the independent variables according to gender and ethnicity. As shown in Table 8 and 9, there is an increase in the odds of association between the awareness of one's diabetes risk with the adoption of diabetes risk reduction behavior in both males and females. However, non-Hispanic black, non-Hispanic white and Mexican American males and females did not show statistical significance between the awareness of one's diabetes risk and the adoption of diabetes risk reduction behavior. Association of age and the adoption of diabetes risk reduction behavior was higher among Mexican American males and females compared to non-Hispanic white and black males and females. Education and annual family income both showed an increase in the odds of association for the adoption of diabetes risk reduction behavior, however they are not statistically significant in both males and females. BMI is the only statistically significant variable adjusting for the other variables and shows an increase in odds of adoption of diabetes risk reduction behavior in both males and females Non-Hispanic black females and non-Hispanic white males showed a higher association between BMI and the adoption of diabetes risk reduction behavior. Age, hypertension, mean systolic blood pressure, mean diastolic blood pressure, total cholesterol, LDL, HDL, and triglycerides do not show statistical significance among both males and females.

CHAPTER V

DISCUSSION AND CONCLUSION

5a. Discussion

Identification of the awareness of one's diabetes risk and prediabetes status is potentially important for the initiation and implementation of several prevention and structured lifestyle interventions. Adoption of lifestyle modifications such as weight control, physical activity, and reduction in fat/calories in one's diet may improve the health of those high-risk individuals, but particularly among those groups of individuals that reported these behaviors less frequently; which include men, non-Hispanic blacks, and normal weight people (Geiss et al., 2010). In addition, clinical trials provide strong and consistent evidence that type 2 diabetes can be prevented or delayed in high-risk adults with prediabetes through these structured lifestyle modifications (Geiss et al., 2010). Therefore, the knowledge and discovery of what lifestyle changes adults with prediabetes are currently making and factors associated with these changes may be useful in planning effective lifestyle interventions. Although there have been studies that have identified those who are at risk for diabetes and prediabetes and examined those individuals that engage in diabetes risk reduction behaviors (ie. weight control, physical activity and diet), few of them have looked at specific ethnic groups and the association of the awareness of diabetes risk and other risk factors involved in the adoption of diabetes risk reduction behavior. This study is unique and particularly important for the development of interventions and lifestyle changes specific for those individuals, ethnic groups and genders that are at a high risk for development of type 2 diabetes.

The objective of this study was to use nationally representative data to identify whether one's awareness of diabetes risk is associated with the adoption of diabetes risk reduction behavior (combination of weight control, physical activity and reduction in fat/calories in diet) and whether this relationship would vary by gender and ethnicity. Other risk factors such as age, education, annual family income, BMI, hypertension, mean systolic blood pressure, mean diastolic blood pressure, total cholesterol, LDL, HDL, and triglycerides were also examined.

Results of the study indicated that the awareness of one's diabetes risk is associated with the adoption of diabetes risk reduction behavior. One study by Geiss et al. examined lifestyle changes consistent with reducing diabetes risk and factors associated with their adoption among adults with prediabetes. The study by Geiss et al. is similar to the present study, however, it was not able to examine how awareness of prediabetes was associated with reduction behaviors due to the small number of people who were aware of prediabetes (2010). In addition, the methodology, the analyses, study variables, and the sample population that met the eligibility criteria of the study by Geiss et al. also differed compared to this study. For example, Geiss et al. modeled the three risk reduction behaviors separately in their multiple logistic regression analysis instead of combining them into a single variable and they defined prediabetes differently from the current study. Unlike the Geiss et al. study, the present study stratified the analyses according to gender and ethnicity. In this study it was found that non-Hispanic black males and females were more likely to engage in diabetes risk reduction behaviors. However, stratification according to race and gender indicated that Mexican American males and females, who were aware of their diabetes risk, were more likely to adopt diabetes risk reduction behavior compared to non-Hispanic white and blacks. An increase in the level of education, annual family income and BMI was also associated with the adoption of diabetes risk reduction behavior. Specifically, results indicated that non-Hispanic black females and Mexican American males were more likely to adopt diabetes risk reduction behavior if they had higher levels of education. Similarly, Geiss et al. found that those with less than high school education were least likely to report increasing physical activity in the past year, which is consistent with this study that those with a lower level of education are least likely to engage in diabetes risk reduction behavior.

This study is also consistent with the finding by Geiss et al. that women were more likely than men to engage in diabetes risk reduction behavior. In regards to annual family income, Mexican American males and females reported having a higher annual family income in association with adoption of diabetes risk reduction behavior. It was also found that non-Hispanic black females and non-Hispanic white males had higher BMI which in turn was associated with adoption of diabetes risk reduction behavior. This is consistent with the Geiss et al. finding that, generally, those of normal BMI are less likely than overweight or obese adults to report engaging in each diabetes risk reduction activity (2010). Geiss et al. also reported that race/ethnicity was associated with reports of two of the diabetes risk reduction activities-trying to control or lose weight and reducing fat and calories-with non-Hispanic whites being more likely than other race and ethnic groups to report these behaviors (2010). Another study by Tuomilehto et al. found that many subjects with impaired glucose tolerance are both obese and inactive and therefore it might be expected to find a dose-response relation between the correction of these multiple risk factors and reductions in the risk of diabetes (2001). Counseling those individuals with a higher BMI about effective diabetes risk reduction practices and behaviors which may include physical activity, exercise, and diet may reduce their diabetes risk.

Results from the multivariate analyses of this study showed that an increase in the unit or levels of hypertension, mean systolic blood pressure, mean diastolic blood pressure, total cholesterol, LDL, HDL, and triglyceride levels lead to a higher probability of the adoption of diabetes risk reduction behavior. However, none of the variables showed a significant association. The analyses by Geiss et al., was not able to determine the association between each of the mentioned variables and the adoption of diabetes risk reduction behavior. However, the analyses showed that compared to people without prediabetes, adults with prediabetes were more likely to have higher levels of well-known cardiovascular disease risk factors, including higher mean weight, waist circumference, systolic blood pressure, and triglyceride levels as well as a higher prevalence of hypertension (Geiss et al.., 2010). Therefore, the present study and the study by Geiss et al. indicate that efficient identification of prediabetes or the awareness of one's diabetes risk may lead to opportunities for better cardiovascular risk factor management along with initiation of preventive behaviors to lower diabetes risk (Geiss et al., 2010).

CDC provided the first nationally representative estimates of the prevalence of self-reported prediabetes in the U.S. adult population and the first estimates of the prevalence of risk reduction activities among adults who had been told they had prediabetes from the 2006 National Health Interview Survey (CDC, 2008). This report differed from the present study in that it also, like the study by Geiss et al., did not show the association between the awareness of diabetes risk and the adoption of diabetes risk reduction behavior in the presence of other risk factors. However, results of the study indicated that among those who had been told they had prediabetes, 68% had tried to lose or control weight, 55% had increased physical activity or exercise, 60% had reduced dietary fat or calories, and 42% had engaged in all three activities (CDC, 2008). The diabetes risk reduction behavior characteristics of the present study indicated that about 40% of U.S .female adults and about 25% of U.S. male adults engaged in diabetes risk reduction behavior (combination of weight control, physical activity and diet).

5b. Strengths and Limitations

The major strength of the present study is the use of NHANES 2007-2008 data. NHANES is unique in that it is representative of the U.S. population and that the data could be generalized to the whole U.S. population. In addition, the biological risk factor data were collected using standardized laboratory and physical measurements. Personnel were also systematically trained to collect laboratory data and physical measurements. However, there are also a number of limitations. First, because of the cross-sectional nature of the data, only associations, not causality, can be examined. The cross-sectional data only provides a snapshot of the population, at that one point in time and cannot determine the cause-effect relationship for that specific time period. Prospective studies of interventions and policies to promote and maintain healthy lifestyles are needed (Geiss et al., 2010). Second, the data on variables such as age, education, annual family income and risk reduction behaviors were based on self-reports and, thus may be influenced by the accuracy of recall, self-report bias and social desirability bias. Misclassification bias may have occurred when participants were classified into different categories. Third, the study was restricted to certain variables and could have included the variables family history and physician advice for the identification of those who have prediabetes and those that are influenced by their physicians to engage in diabetes risk reduction activities. Fourth, the analyses presented are not weighted and did not account for the complex sampling design used with NHANES. Finally, a number of other important questions were not addressed by the current study including why and when physicians provided lifestyle counseling, and whether and what type of counseling is effective (Geiss et al., 2010).

5c. Clinical and Public Health Implications

U.S. adults with prediabetes and who are aware of their diabetes risk may make behavioral and lifestyle changes to reduce their diabetes risk. However, it is important that health care providers, physicians and other public health professionals provide advice and interventions to increase the promotion of risk reduction behaviors and healthy lifestyles as well as community-level programs that are evidence-based for those people at high risk for type 2 diabetes.

The multivariate analyses of this study have indicated that Mexican Americans, who are aware of their diabetes risk, are more likely to adopt and engage in diabetes risk reduction behaviors. Therefore, it is important for physicians and health care providers to develop culturally and linguistically appropriate education materials for this particular ethnic group. This study also indicated that SES factors such as education and annual family income influence the adoption of diabetes risk reduction behaviors. Therefore, effective population-based interventions that decrease obesity, diabetes risk and improve health behaviors should be implemented to reduce SES and racial/ethnic disparities. According to the study by Tuomilehto et al., the reasonably low dropout rate in their study indicated that subjects with impaired glucose tolerance are willing and able to participate in a demanding intervention prevention program if it is made available to them (Tuomilehto et al., 2001). Therefore, provision of readily available intervention and diabetes prevention programs is important to reduce an individual's risk for diabetes and to reverse U.S national trends in diabetes incidence. Finally, more efficient identification and awareness of risk on the part of patients, their providers, healthcare systems, and health payers are likely to be a key first step to implementing these changes (Geiss et al., 2010).

5d. Conclusion

Diabetes is a major health problem in both men and women and in the three main racial ethnic groups (non-Hispanic white, non-Hispanic black and Mexican Americans) in the U.S. Using NHANES 2007-2008 data, the results of this study indicate that prediabetes and the awareness of one's diabetes risk, in the presence of other risk factors, may influence or encourage one's decision in the adoption and participation in diabetes risk reduction behaviors. This study also provides useful insights for health care providers and public health professionals who are developing health promotion and prevention interventions to address prediabetes before it develops into type 2 diabetes. Although it has been demonstrated that behavioral and chemotherapeutic interventions can delay or prevent type 2 diabetes, these interventions have not been successfully implemented in large-scale clinical or population-based programs (Robbins et al., 2005).

The examination of the three ethnic groups andmales and females separately may provide information useful in the development of interventions specifically targeted for those groups that are aware of their health risk and are most likely to adopt diabetes risk reduction behaviors. In addition, the many risk factors, such as education, family income and BMI, that may affect one's engagement in diabetes risk reduction activities, may also be addressed to eliminate or reduce gender, racial and SES disparities. Prevention efforts targeted towards the specifically mentioned gender and ethnic groups may reduce the overall increasing prevalence of diabetes, reduce disparities and may have a positive impact on the overall health of the U.S. population.

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Appendices

Table1 . Demographic and biological characteristics of U.S. male adults ages 20 and above

	Mexican Americans	Non-Hispanic Whites	Non-Hispanic blacks	p-value
Sociodemographic Characteristics	(n) % or mean ± SD	(n) % or mean± SD	(n) % or mean± SD	
Age	42.3± 15.6[a]	51.4± 18.7[b]	46.5± 16.8[c]	**<0.001**
Education				
< High School	(139) 33.7[a]	(75) 6.6[b]	(38) 8.2[c]	
High School	(175) 42.4[a]	(447) 39.5[b]	(224) 48.6[c]	**<0.001**
College	(99) 24.0[a]	(610) 53.9[b]	(199) 43.2[c]	
Annual Family Income				
Less than $20,000	(114) 29.8[a]	(233) 21.1[b]	(107) 24.3[c]	
$20,000-$74,999	(220) 57.4[a]	(562) 50.9[b]	(242) 54.9[c]	**< 0.001**
$75,000 +	(49) 12.8[a]	(309) 28.0[b]	(92) 20.9[c]	
Body Measures				
BMI				
Normal	(90) 23.7[a]	(322) 29.7[b]	(162) 37.3[a]	
Overweight	(164) 43.2[a]	(439) 40.5[b]	(136) 31.3[a]	**< 0.001**
Obese	(126) 33.2[a]	(322) 29.7[b]	(136) 31.3[a]	
Clinical Characteristics				
Hypertension				
Yes	(101) 24.5[a]	(461) 40.7[a]	(185) 40.1[b]	**<0.001**
No	(312) 75.5[a]	(672) 59.3[a]	(276) 59.9[b]	
Mean Systolic BP	123.4± 14.2[a]	125.1± 15.9 [a,b]	126.6± 19.3[b]	**0.032**
Mean Diastolic BP	72± 11.5[a]	71.8± 12.4[a,b]	73.9± 12.2[b]	**0.016**
Total Cholesterol	200.7± 41.1[a]	193.6± 41.0[a]	193.4± 40.6[b]	**0.011**
LDL	119.8± 30.7[a]	116.6± 35.0[a]	115.0± 37.7[a]	0.425
HDL	45.4± 11.9[a]	46.6± 13.0[a]	53.8± 16.6[b]	**< 0.001**
Triglycerides	151.4± 88.5[a]	148.2± 126.6[b]	101.1±61.4[b]	**<0.001**

*Pairwise comparisons were done using Tukey posthoc tests and Chi-square tests for continuous and categorical variables. Values with different superscripts differ at p<0.05 levels

Table 2. Demographic and biological characteristics of U.S. female adults ages 20 and above

Sociodemographic Characteristics	Mexican Americans (n) % or mean±SD	Non-Hispanic Whites (n) % or mean±SD	Non-Hispanic Blacks (n) % or mean±SD	p-value
Age	42.6± 15.8[a]	52.2± 18.3[b]	46.5± 17.1[c]	**< 0.001**
Education				
< High school	(106) 24.9[a]	(53) 4.6[a]	(25) 5.2[b]	
High school	(184) 43.2[a]	(469) 40.3[a]	(218) 44.9[b]	**< 0.001**
College	(136) 31.9[a]	(641) 55.1[a]	(242) 49.9[b]	
Annual Family Income				
Less than $20,000	(110) 27.0[a]	(287) 25.6[b]	(142) 30.3[b]	
$20,000-$74,999	(241) 59.1[a]	(559) 49.9[b]	(243) 51.9[b]	**< 0.001**
$75,000 +	(57) 14.0[a]	(275) 24.5[b]	(83) 17.7[b]	
Body Measures				
BMI				
Normal	(99) 24.1[a]	(435) 39.3[b]	(119) 25.6[b]	
Overweight	(141) 34.3[a]	(346) 31.3[b]	(143) 30.8[b]	**< 0.001**
Obese	(171) 41.6[a]	(326) 29.4[b]	(203) 43.7[b]	
Clinical Characteristics				
Hypertension				
Yes	(97) 22.7[a]	(453) 39.0[b]	(217) 44.7[c]	**<0.001**
No	(331) 77.3[a]	(710) 61.0[b]	(268) 55.3[c]	
Mean Systolic BP	117.0± 17.9[a]	122.1± 18.7[b]	123.5± 20.2[b]	**< 0.001**
Mean Diastolic BP	66.8± 12.3[a]	69.3± 11.6[b]	70.0± 12.5[b]	**< 0.001**
Total Cholesterol	197.4± 39.6[a]	205.3± 41.0[a]	195.2± 41.7[b]	**< 0.001**
LDL	117.1± 33.5[a]	119.3± 34.2[a,b]	111.6± 35.8[b]	**< 0.001**
HDL	52.8± 14.2[a]	58.4± 17.3[b]	62.5± 17.8[c]	**< 0.001**
Triglycerides	131± 83.7[a]	122.9± 74.5[b]	86.1± 61.3[b]	**< 0.001**

*Pairwise comparisons were done using Tukey post hoc tests and Chi square tests for continuous and categorical variables. Values with different superscripts differ at p<0.05 levels

Table 3: Diabetes Risk Reduction behavior characteristics of U.S male adults above 20

	Non-Hispanic Whites % (n)	Non-Hispanic Blacks % (n)	Mexican Americans % (n)	P-value
On Going Lifestyle Changes				
Controlling Weight				
No	55.3 (627)[a]	50.1 (231)[a]	64.2 (265)[b]	**< 0.001**
Yes	44.7 (506)[a]	49.9 (230)[a]	35.8 (148)[b]	
Increasing Physical Activity				
No	60.3 (683)[a]	46.2 (213)[b]	61.0 (252)[a]	**< 0.001**
Yes	39.7 (450)[a]	53.8 (248)[b]	39.0 (161)[a]	
Reducing Fat or Calories in Diet				
No	59.7 (676)[a]	54.0 (249)[b]	59.3 (245)[a,b]	0.100
Yes	40.3 (456)[a]	46.0 (212)[b]	40.7 (168)[a,b]	
Past Year Lifestyle Changes				
Controlling Weight				
No	81.4 (922)[a]	85.5 (394)[a]	83.1 (343)[a]	0.144
Yes	18.6 (211)[a]	14.5 (67)[a]	16.9 (70)[a]	
Increasing Physical Activity				
No	76.5 (866)[a]	80.9 (373)[a]	79.7 (329)[a]	0.110
Yes	23.5 (266)[a]	19.1 (88)[a]	20.3 (84)[a]	
Reducing fat/calories in diet				
No	79.6 (901)[a]	80.7 (372)[a]	79.2 (327)[a]	0.837
Yes	20.4 (231)[a]	19.3 (89)[a]	20.8 (86)[a]	
*Diabetes Risk Reduction Behavior				
No	75.2 (852)[a]	68.3 (315)[b]	76.0 (314)[a]	**0.009**
Yes	248 (281)[a]	31.7 (146)[b]	24.0 (99)[a]	

Diabetes risk reduction behavior was defined as a combination of ongoing weight control, physical activity and reduction in fat/calories intake. Pairwise comparisons were done using Chi-square tests for categorical variables. Values with different superscript (a,b,c) differ at a p-value< 0.05. Boldface indicates significance (p<0.05)

Table 4. Diabetes Risk Reduction behavior characteristics of U.S. female adults above 20

	Non-Hispanic Whites % (n)	Non-Hispanic Blacks % (n)	Mexican Americans % (n)	P-value
On Going Lifestyle Changes				
Controlling Weight				
No	47.9 (557)[a]	41.6 (202)[b]	52.1 (223)[a]	**0.006**
Yes	52.1 (606)[a]	58.4 (283)[b]	47.9 (205)[a]	
Increasing Physical Activity				
No	52.0 (604)[a]	44.7 (217)[b]	52.6 (225)[a]	**0.017**
Yes	48.0 (558)[a]	55.3 (268)[b]	47.4 (203)[a]	
Reducing Fat or Calories in Diet				
No	48.5 (564)[a]	43.9 (213)[a]	43.7 (187)[a]	0.105
Yes	51.5 (599)[a]	56.1 (272)[a]	56.3 (241)[a]	
Past Year Lifestyle Changes				
Controlling Weight				
No	80.7 (938)[a]	67.8 (329)[b]	75.2 (322)[c]	**< 0.001**
Yes	19.3 (225)[a]	32.2 (156)[b]	24.8 (106)[c]	
Increasing Physical Activity				
No	70.8 (822)[a]	60.4 (293)[b]	67.1 (287)[a]	**< 0.001**
Yes	29.2 (339)[a]	39.6 (192)[b]	32.9 (141)[a]	
Reducing fat/calories in diet				
No	78.2 (910)[a]	64.1 (311)[b]	69.9 (299)[a,b]	**< 0.001**
Yes	21.8 (253)[a]	35.9 (174)[b]	30.1 (129)[a,b]	
*Diabetes Risk Reduction Behavior				
No	65.1 (757)[a]	59.8 (290)[b]	65.7 (281)[a,b]	0.087
Yes	34.9 (406)[a]	40.2 (195)[b]	34.3 (147)[a,b]	

Diabetes risk reduction behavior was defined as a combination of ongoing weight control, physical activity and reduction in fat/calories intake. Pairwise comparisons were done using Chi-square tests for categorical variables. Values with different superscripts (a,b,c) differ at p-value < 0.05. Boldface indicates significance (p<0.05)

Table 5. Association between awareness of one's diabetes risk with adoption of diabetes risk reduction behavior in U.S male adults ages 20 and above by ethnicity.

Characteristics	**Non-Hispanic Whites**	**Non-Hispanic Blacks**	**Mexican Americans**
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**
Aware of Diabetes Risk			
No[r]			
Yes	2.373 (1.622-3.473)	2.031 (1.004-4.107)	2.505 (1.285-4.885)
Age	1.009 (1.001-1.016)	0.998 (0.986-1.009)	1.009 (0.995-1.024)
Education			
< High school[r]			
High school	0.828 (0.454-1.513)	2.817 (1.054-7.528)	1.352 (0.760-2.406)
College	1.580 (0.886-2.820)	3.907 (1.461-10.447)	3.278 (1.795-5.987)
Annual Family Income			
Less than $20,000[r]			
$20,000-$74,999	1.583 (1.075-2.332)	1.087 (0.657-1.799)	1.327 (0.759-2.320)
$75,000 +	2.079 (1.373-3.148)	1.974 (1.095-3.561)	3.136 (1.508-6.524)
BMI			
Normal[r]			
Overweight	3.486 (2.312-5.257)	3.608 (2.112-6.163)	1.777 (0.923-3.419)
Obese	4.518 (2.959-6.896)	3.395 (1.985-5.807)	1.848 (0.936-3.646)
Hypertension			
No[r]			
Yes	1.642 (1.252-2.155)	1.152 (0.773-1.717)	1.302 (0.782-2.168)
Mean Systolic BP	0.999 (0.990-1.008)	0.987 (0.975-0.999)	0.996 (0.978-1.014)
Mean Diastolic BP	1.000 (0.989-1.011)	1.004 (0.986-1.022)	1.014 (0.992-1.037)
Total Cholesterol	0.997 (0.994-1.001)	1.004 (0.999-1.009)	1.000 (0.994-1.006)
LDL	1.000 (0.994-1.005)	0.999 (0.991-1.007)	1.004 (0.992-1.015)
HDL	0.995 (0.984-1.006)	0.992 (0.979-1.005)	1.002 (0.982-1.022)
Triglycerides	1.001 (0.999-1.002)	0.999 (0.994-1.004)	0.999 (0.995-1.003)

* P< 0.05; [r] Reference group; Diabetes risk reduction behavior was defined as a combination of ongoing weight control, physical activity and reduction in fat or calories intake.

Table 6. Association between awareness of one's diabetes risk with adoption of diabetes risk reduction behavior in U.S. female adults ages 20 and above by ethnicity.

Characteristics	Non-Hispanic Whites	Non-Hispanic Blacks	Mexican Americans
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**
Aware of Diabetes Risk			
No[r]			
Yes	2.081 (1.508-2.871)	2.117 (1.306-3.429)	3.459 (2.058-5.814)
Age	0.997 (0.991-1.004)	1.000 (0.990-1.011)	1.011 (0.999-1.024)
Education			
< High school[r]			
High school	1.003 (0.534-1.884)	1.852 (0.667-5.140)	1.175 (0.702-1.967)
College	1.707 (0.920-3.166)	4.000 (1.454-11.003)	1.477 (0.861-2.532)
Annual Family Income			
Less than $20,000[r]			
$20,000-$74,999	1.474 (1.072-2.026)	1.301 (0.844-2.005)	1.159 (0.712-1.889)
$75,000 +	2.667 (1.868-3.806)	2.435 (1.397-4.242)	2.100 (1.085-4.066)
BMI			
Normal[r]			
Overweight	1.664 (1.233-2.245)	4.010 (2.239-7.182)	1.760 (0.984-3.147)
Obese	1.707 (1.260-2.312)	5.409 (3.109-9.412)	2.129 (1.218-3.721)
Hypertension			
No[r]			
Yes	1.207 (0.943-1.543)	1.612 (1.118-2.324)	1.469 (0.923-2.339)
Mean Systolic BP	0.999 (0.992-1.007)	1.005 (0.995-1.015)	1.008 (0.996-1.020)
Mean Diastolic BP	1.017 (1.005-1.029)	1.027 (1.009-1.044)	1.009 (0.991-1.027)
Total Cholesterol	0.999 (0.996-1.002)	0.998 (0.993-1.003)	1.001 (0.996-1.006)
LDL	0.995 (0.989-1.000)	0.994 (0.986-1.003)	0.996 (0.986-1.006)
HDL	0.998 (0.991-1.006)	0.993 (0.982-1.005)	0.987 (0.972-1.002)
Triglycerides	1.002 (0.999-1.004)	1.005 (0.999-1.010)	1.001 (0.998-1.005)

* $P<0.05$; [r]Reference group; Diabetes risk reduction behavior was defined as a combination of ongoing weight control, physical activity and reduction in fat or calories intake.

Table 7. Association between awareness of one's diabetes risk with adoption of diabetes risk reduction behavior for U.S male and female adults ages 20 and above. (Multivariate Analysis)

Characteristics	OR	95% Confidence Interval
Aware of Diabetes Risk		
No[r]		
Yes	1.734	1.217-2.470
Age	1.006	0.997-1.015
Gender		
male[r]		
female	1.405	1.084-1.821
Race		
Non-Hispanic whites[r]		
Non-Hispanic blacks	1.459	1.070-1.989
Mexican Americans	1.108	0.791-1.551
Education		
< High school[r]		
High school	1.127	0.694-1.832
College	1.833	1.118-3.004
Annual Family Income		
Less than $20,000[r]		
$20,000-$74,999	1.213	0.886-1.661
$75,000 +	1.920	1.319-2.794
BMI		
Normal[r]		
Overweight	2.049	1.511-2.780
Obese	2.295	1.649-3.195
Hypertension		
No[r]		
Yes	1.060	0.771-1.457
Mean Systolic BP	0.995	0.986-1.004
Mean Diastolic BP	1.010	0.999-1.022
Total Cholesterol	0.838	0.545-1.288
LDL	1.189	0.773-1.827
HDL	1.188	0.773-1.826
Triglycerides	1.035	0.950-1.128

Table 8: Association between awareness of one's diabetes risk with adoption of diabetes risk reduction behavior for U.S. male adults ages 20 and above (Multivariate analysis).

Characteristics	Non-Hispanic Whites	Non-Hispanic Blacks	Mexican Americans
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Aware of Diabetes Risk			
No[r]			
Yes	1.872 (0.910-3.850)	1.775 (0.369-8.532)	2.496 (0.792-7.868)
Age	1.001 (0.986-1.017)	1.000 (0.972-1.029)	1.038 (1.001-1.077)
Education			
< High school[r]			
High school	0.906 (0.284-2.885)	1.812 (0.287-11.442)	1.698 (0.543-5.312)
College	1.815 (0.569-5.791)	2.234 (0.357-13.963)	2.419 (0.699-8.377)
Annual Family Income			
Less than $20,000[r]			
$20,000-$74,999	1.029 (0.523-2.025)	0.699 (0.272-1.795)	1.426 (0.494-4.121)
$75,000+	1.212 (0.584-2.515)	0.697 (0.219-2.226)	1.341 (0.283-6.364)
BMI			
Normal[r]			
Overweight	2.316 (1.240-4.328)	3.626 (1.429-9.200)	1.660 (0.517-5.328)
Obese	3.592 (1.807-7.142)	2.524 (0.882-7.225)	1.254 (0.315-4.992)
Hypertension			
No[r]			
Yes	1.185 (0.675-2.082)	1.221 (0.446-3.343)	1.314 (0.377-4.579)
Mean Systolic BP	1.002 (0.985-1.020)	0.970 (0.940-1.001)	0.997 (0.958-1.038)
Mean Diastolic BP	1.005 (0.986-1.025)	1.022 (0.983-1.063)	1.004 (0.960-1.049)
Total Cholesterol	1.220 (0.537-2.772)	0.404 (0.104-1.574)	1.389 (0.326-5.923)
LDL	0.818 (0.360-1.859)	2.471 (0.634-9.625)	0.720 (0.169-3.071)
HDL	0.818 (0.360-1.859)	2.477 (0.635-9.668)	0.712 (0.167-3.037)
Triglycerides	0.959 (0.813-1.130)	1.198 (0.912-1.573)	0.934 (0.698-1.249)

$P<0.05$; [r]Reference Group. Diabetes risk reduction behavior was defined as a combination of ongoing weight control, physical activity and reduction in fat or calories intake.

Table 9: Association between awareness of one's diabetes risk with adoption of diabetes risk reduction behavior for U.S. female adults ages 20 and above. (Multivariate analysis).

Characteristics	Non-Hispanic Whites	Non-Hispanic Blacks	Mexican Americans
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Aware of Diabetes Risk			
No[r]			
Yes	1.687 (0.897-3.171)	1.501 (0.537-4.195)	2.830 (0.917-8.736)
Age	1.003 (0.985-1.020)	1.012 (0.981-1.045)	1.012 (0.977-1.048)
Education			
< High school[r]			
High school	1.014 (0.301-3.411)	4.811 (0.340-68.057)	0.866 (0.269-2.781)
College	1.800 (0.539-6.010)	8.549 (0.570-128.256)	1.039 (0.317-3.406)
Annual Family Income			
Less than $20,000[r]			
$20,000-$74,999	1.959 (1.059-3.623)	1.005 (0.414-2.441)	1.307 (0.445-3.833)
$75,000 +	4.041 (1.999-8.169)	1.757 (0.536-5.762)	7.297 (1.428-37.288)
BMI			
Normal[r]			
Overweight	1.455 (0.843-2.512)	5.898 (2.003-17.362)	1.895 (0.573-6.267)
Obese	1.690 (0.910-3.138)	4.296 (1.505-12.260)	2.425 (0.757-7.770)
Hypertension			
No[r]			
Yes	0.727 (0.396-1.336)	1.612 (0.569-4.569)	0.900 (0.216-3.743)
Mean Systolic BP	1.010 (0.992-1.029)	0.988 (0.959-1.017)	0.988 (0.953-1.025)
Mean Diastolic BP	1.001 (0.979-1.024)	1.010 (0.976-1.046)	1.022 (0.977-1.069)
Total Cholesterol	0.698 (0.313-1.556)	0.461 (0.116-1.828)	1.495 (0.296-7.546)
LDL	1.425 (0.639-3.178)	2.142 (0.541-8.483)	0.665 (0.132-3.354)
HDL	1.424 (0.639-3.174)	2.126 (0.537-8.418)	0.652 (0.129-3.298)
Triglycerides	1.076 (0.916-1.263)	1.169 (0.887-1.540)	0.922 (0.666-1.276)

- $P<0.05$; [r]Reference Group. Diabetes risk reduction behavior was defined as a combination of ongoing weight control, physical activity and reduction in fat or calories intak