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ASSOCIATIONS OF RACE, AGE, AND SOCIOECONOMIC STATUS AMONG WOMEN WITH PREDIABETES:

AN EXAMINATION OF NHANES DATA 2005-2006 REGARDING PREDIABETES RISK

by

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BVSc, KERALA AGRICULTURAL UNIVERSITY

A Thesis Submitted to the Graduate Faculty
of Georgia State University in Partial Fulfillment
of the
Requirements for the Degree
MASTER OF PUBLIC HEALTH

ATLANTA, GEORGIA

APPROVAL PAGE

ASSOCIATIONS OF RACE, AGE, AND SOCIOECONOMIC STATUS AMONG WOMEN WITH PREDIABETES: AN EXAMINATION OF NHANES DATA 2005-2006 REGARDING PREDIABETES RISK.

by

ROSE THOMAS KATTAKAYAM

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DEDICATION PAGE

The following thesis document is dedicated to my husband and son and the rest of my family for their constant support and love.

ACKNOWLEDGEMENTS

I am thankful to God who has guided me through each step of my life. I want to thank my husband, son, parents and the rest of my family for all their support and love. I would like to acknowledge my thesis committee, Sheryl M. Strasser, PhD, MPH, MSW, CHES, and Ike S Okosun, MS, MPH, PhD, FRIPH, FRSH, for their guidance and support throughout this thesis. I would also like to thank the Institute of Public Health for believing and supporting me in my journey.

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TITLE OF THESIS:
ASSOCIATIONS OF RACE, AGE, AND SOCIOECONOMIC STATUS AMONG WOMEN WITH PREDIABETES: AN EXAMINATION OF NHANES DATA 2005-2006 REGARDING PREDIABETES RISK

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ABSTRACT

Background: Prediabetes (PD) defined as having glucose values above normal but not high enough to be diagnosed as diabetes, is known to be a risk factor for type 2 diabetes and associated complications. Early prevention efforts can reverse the condition or delay the development of type 2 diabetes. This study examines the sociodemographic risk factors for PD in women.

Methods: Using secondary data from National Health and Nutrition Examination Survey NHANES 2005-2006, chi-square analysis was done to find the prevalence of the disease among different categories of women with respect to age, ethnicity, and socioeconomic status. Univariate and multivariate analyses were performed to determine the associations of the sociodemographic factors with PD among women. A p-value of <0 .05 and 95% confidence intervals were used to determine statistical significance throughout all the analyses performed.

Results: In total, 3,461 cases were included in the study analysis. Cases with indications of PD were found in 716 (20.7%) of the sample. Increased age was consistently associated with PD in women [χ=392.3(3), p<.001]. Prevalence of PD peaked for those aged 60 and above. Results of multivariate analysis suggested that being non-Hispanic Blacks was associated with increased likelihood of PD. Education was found to be significantly associated with PD but an inverse relationship could not be established.

Conclusions: As an increase in age was found to be associated with PD in women, early screening and education regarding lifestyle changes can help reverse the condition. Minority groups should be an important focus for PD prevention efforts.

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CHAPTER I
INTRODUCTION

1a. Background

Diabetes is a group of diseases in which high levels of glucose are present in the blood due to defects in insulin production, action or both (CDC, 2007; ADA, 2008). There are three different types of diabetes- Type 1, Type 2 and Gestational Diabetes Mellitus (GDM). The disease and its complications are the major causes of morbidity, mortality, reduced quality of life (CDC, 2007) and economic loss in the U.S (Hogan, Dall, & Nikolov, 2003). The recent trends show that over the next 50 years the number of Americans with diagnosed diabetes will increase (Boyle et al., 2001). Another condition known as prediabetes (PD) has also been recognized and is defined as a state that occurs when a person's blood glucose levels are higher than normal but not high enough for a diagnosis of diabetes. In 2007, an estimated 57 million people aged 20 years and older had PD in the U.S (National Institute of Health (NIH), 2008).

There are concerns about people having prediabetic conditions, as an increased risk of type 2 diabetes is associated with those diagnosed with PD (Tuomilehto et al., 2001). A study by de Vegt et al in a Dutch population found that the risk of development of type 2 diabetes was more than 10 times in those who had PD (2001). PD can eventually progress to developing cardiovascular diseases (Coutinho, Wang, Gerstein, Hertzel & Yusuf, 1999; Meigs, Nathan, D'Agostino, & Wilson, 2002). The complications of diabetes depend on the glycemic levels and the duration (Nathan et al., 2007).

The public health burden of the disease is enormous in terms of the health care expenditure. Even the lowest prediabetic levels have been found to be associated with increased medical costs (Nichols & Brown, 2005). In a study by Zhang and colleagues, medical claims data to estimate per capita excess health care use was combined with national estimates of health care use and medical costs to calculate national expenditures associated with PD. The results of the study were extrapolated to suggest that national annual medical costs of PD exceed 25 billion dollars or an additional $443 dollars for each adult with PD (2009).

The diagnosis of PD or borderline diabetes is important as scientific evidence suggests that the progression to type 2 diabetes and its associated complications can be delayed or reversed. Lifestyle changes can prevent or delay development of type 2 diabetes among persons with PD irrespective of their age, race and sex (Diabetes Prevention Program Research Group, 2002).

1b. Purpose of Study

Blood glucose levels that are not within a diagnosable level of diabetes do not indicate that a person is free from diabetes-complications or risks. There are no studies that were conducted to find the prevalence of PD in various subgroups of women. The purpose of this study is to examine the of associations of age, race and socioeconomic status among a female NHANES sample, whose blood glucose levels are elevated but not high enough to be diagnosed as diabetes. This study will examine reported borderline diabetes as well as laboratory variables such as fasting plasma glucose levels, glucose tolerance levels or glycalated hemoglobin percentages in women to determine whether they have a prediabetic condition.

Using NHANES 2005-2006 data, the prevalence rates of borderline diabetes among women by race, age, and SES variables such as income, poverty income ratio (PIR) and education were examined. This study is important because PD is an early warning sign for development of type 2 diabetes and associated complications. The results of this study will help shed light on how widespread PD is among diverse groups of women —and subsequently, findings can help inform directions for future preventive efforts.

1c. Research Questions

Question #1: What percentage of female NHANES 2005-2006 sample has PD?

Null Hypothesis #1: The prevalence of self-reported PD in a female NHANES 2005-2006 sample is not different from actual prevalence of PD.

Alternate Hypothesis #1: The prevalence of self-reported PD in a female NHANES 2005-2006 sample is different from actual prevalence of PD.

Question #2: How does PD in a female NHANES 2005 - 2006 sample differ by age?

Null Hypothesis #2: PD in women is not associated with age in NHANES 2005-2006 sample.

Alternate Hypothesis #2: PD in women is associated with age in NHANES 2005-2006 sample.

Question #3: How is PD in a female NHANES 2005-2006 sample different by ethnicity?

Null Hypothesis #3: PD in women is not associated with ethnicity in NHANES 2005-2006 sample.

Alternate Hypothesis #3: PD in women is associated with ethnicity in NHANES 2005-2006 sample.

Question #4: How is PD in a female NHANES 2005-2006 sample different by education?

Null Hypothesis #4: PD in women is not associated with education in NHANES 2005-2006 sample.

Alternate Hypothesis #4: PD in women is associated with education in NHANES 2005-2006 sample.

Question #5: How is PD in a female NHANES 2005-2006 sample different by family income levels?

Null Hypothesis #5: PD in women is not associated with family income in NHANES 2005-2006 sample.

Alternate Hypothesis #5: PD in women is associated with family income in NHANES 2005-2006 sample.

Question #6: How is PD in a female NHANES 2005 2006 sample different by Poverty income ratio (PIR)?

Null Hypothesis #6: PD in women is not associated with PIR in NHANES 2005-2006 sample.

Alternate Hypothesis #6: PD in women is associated with PIR in NHANES 2005-2006 sample.

CHAPTER II
REVIEW OF THE LITERATURE

The literature review examined risk factors for PD as well as complications of having prediabetic glucose levels in females. The following chapter is dedicated to presenting scientific literature that supports inclusion of the variables of interest in this study. Since there are very limited studies on PD, risk factors for diabetes were examined as they align naturally with the risk factors for PD.

2a. Biology

Typically, PD does not have any physical symptoms aside from darkening of the skin in some areas of the body, such as neck, elbows, armpits, knees and knuckles (MayoClinic.com, n.d.). In some people, symptoms of diabetes such as increased thirst, frequent urination, fatigue and blurred vision may be present. PD can be diagnosed with Impaired Fasting Glucose (IFG) or Impaired Glucose Tolerance (IGT) or both (American Diabetes Association (ADA), 2008). An FPG level of 100-125 mg/dl or OGT levels of 140-200 mg/dl (NIH, 2008) is classified as PD. The A1C test which measures the glycalated hemoglobin is yet another recommendation to determine the glucose levels in the blood (ADA, 2009). An A1C of 5.7 – 6.4 percent indicates that blood glucose levels are in the prediabetic levels.

The IFG and the OGT measure two different phenomena physiologically (Nathan et al., 2007). The fasting glucose test is more reproducible, less costly and widely

recommended by the ADA. The IGT is more sensitive and can detect defects in glucose levels in the aged (Wahl et al., 1998). The addition of a 2 hour OGTT will add an additional 2% to the original prevalence of diagnosed diabetes using IFG (Cowie et al., 2009).

The studies measuring the total IFG also referred to as the Impaired Plasma Glucose (IPG) and the OGT are very few. Cowie et al. compared the prevalence rates of IFG and IGT for the years 1988-1994 and 2005-2006 using NHANES data. The researchers found that just above 25% of the population had IFG. The prevalence of IGT was about half that of IFG. The total PD was calculated using IFG or IGT levels and estimated to be about 30% in the study (2008). The prevalence of self-reported PD was found to be 4% using the data from the National Health and Nutrition Examination Survey (NHANES) 2005-2006 (Rolka, Burrows, Li & Geiss, 2008).

2b. PD in women

Different studies have found that prevalence of PD in women to be contradictory. In one study using the data from the National Health Interview Survey, self-reported PD was found to be more prevalent in women (4.8%) than men (3.2%) (Rolka, Burrows, Li & Geiss, 2008). In contrast to this, Cowie et al. found that the crude prevalence of total PD using 2005-2006 data was much greater in men than in women (2008). According to this study, the IFG was found to be higher in men than women while when the IGT levels were compared, no differences between the two genders were observed.

PD and pregnancy studies go back to the late 1950s. In a study by Barnes, the relationship of a prediabetic mother and the negative outcomes such as still births in the

baby have been described (1961). This finding is again strengthened by the study that found an association between fetal outcomes such as perinatal mortality, still birth and PD in mothers (Wood, Sauve, Ross, Brant, & Love, 2000). Children of prediabetic mothers have an eight fold increased risk of PD or diabetes at 19-27 years of age (Damm, 2009). Pregnant women need not reach a diagnostic threshold for gestational diabetes to be at risk for diabetes or prediabetes (Retnakaran, 2008).

2c. Risk Factors

a. Age

One of the risk factors for PD and type 2 diabetes is the age of a person. Women with diabetes were more likely than women without diabetes to be aged 45 years or above (Beckles & Thompson-Reid, 2002). In a study conducted by Rolka and colleagues, it was found that the prevalence of self-reported PD increased with age (2008). The prevalence was found to be 2.7% and 6% in ages 18 to 44 years and above 60 years respectively. 25.9 % who had IGT were 20 and above while 35.4 % were 60 years and older.

In a study by Cowie et al. the variation of the prevalence of IFG, IGT and PD according to age was observed (2008). The results of the study indicated that in individuals over 20 years, the IFG prevalence was 25.7% and it increased with age doubling between 20-39 and 40-59 years of age. After 60 years of age, the IFG levels remained constant with age. About half the prevalence was found in ages 20 years and above for IGT levels and the prevalence increased with age and peaked at 75 years of age with 35.1% prevalence. The total PD estimated by either IFG or IGT was around 30% in ages 20 and above and it increased with age and peaked with 75 years and above.

b. Ethnicity

There are certain population subgroups that are at more risk to develop PD as well as type 2 diabetes. It is not clear why there are racial differences in PD or diabetes prevalence, but behavioral, environmental, socioeconomic, genetic, physiologic risk factors are postulated (Abate & Chandalia, 2003). Some findings indicate that certain race may be at higher risk for type 2 diabetes, regardless of socioeconomic status (SES). Racial or ethnic disparities in diabetes have been increasing in normal and overweight individuals belonging to minority populations (Zhang, Wang, & Huang, 2009). African-Americans, Hispanics, Native Americans, Asian Americans, and Pacific Islanders are at higher risk for type 2 diabetes than Whites (ADA, 2004). The same groups may also develop PD long before they have diabetic glucose levels in the blood and hence screening at an earlier stage in such groups is recommended by the ADA. This is in turn reinforced by a study based on the Behavioral Risk Factor Surveillance System (BRFSS) (Beckles & Thompson-Reid, 2002). It has also been postulated that African-American children are found to have a higher disease risk than White children (Lindquist, Gower, & Goran, 2000).

Persons from minority ethnic groups suffer disproportionately from type 2 diabetes and its long-term complications when compared to Caucasians even though African-American women are more likely to report diabetes than White women (Signorello et al., 2007). A study by Annis et al. found that non-Hispanic Blacks had higher prevalence rates than non-Hispanic Whites or Mexican Americans (Annis, Caulder, Cook, & Duquette, 2005). The prevalence of diabetes in Whites was higher through at least the first half of the 20th century and so it must be thought that the lifestyle

changes in the African-American population may have contributed to the higher rates of prevalence of the disease in the present century.

A higher prevalence of total PD in Mexican Americans than in non-Hispanic Whites or non-Hispanic Blacks was reported by Cowie et al., but it was not significantly different (2008). Although the changes over time in the level of IFG, IGT and PD for the years 1988-2002 and 2005-2006 was compared in this study, no significant changes with ethnicity were observed. When the hemoglobin A1C (HbA1C) levels in diagnosed and undiagnosed diabetes in Whites, Blacks and Hispanics were compared it was found that there were differences between different racial groups (Boltri, Okosun, Davis-Smith, & Vogel, 2005). A study in Mexican Americans using the NHANES 1999-2002 suggested that they are less likely to be aware and to be treated for their diabetic condition than non-Hispanic Whites (Hertz, Unger, & Ferrario, 2006).

c. Socioeconomic Status (SES)

There are no studies done to find associations of PD with SES of a population. Since PD is the precursor of type 2 diabetes, it has been assumed that the same SES factors that affect the prevalence rate of type 2 diabetes will also influence the rates in persons with PD. The prevalence of diabetes varies with SES in a population and can be measured using different variables; the most common ones that are used are education, income and occupation (Abate & Chandalia, 2003; Beckles & Thompson-Reid, 2002). People with low SES have poorer health than other persons (Adler & Ostrove, 1999). SES variables are known risk factors for diabetes mellitus as disadvantaged circumstances may lead to unhealthy behaviors, inadequate access to health care, nutritional inadequacies and also can cause psychological stress (Feinstein, 1993).

Normal glucose levels in humans can be impaired by psychological stress (Wing, Epstein, Blair, & Nowalk, 1985).

SES may also affect diabetes by its influence on prenatal and perinatal factors. Barker and colleagues conducted studies based on animal and epidemiological research to suggest that problems such as diabetes in a person are related to the poor nutritional status of the mother (1994). But there are also questions about the methodology of this study that makes the theory controversial (Joseph and Kramer, 1996). The research done by Beckles & Thompson using the BRFSS data found that the SES of women with diabetes was found to be lower compared to the SES of women without diabetes (2002). SES may be a strong confounder of diabetes in women than men (Signorello et al., 2007). So it is necessary that research attention should focus on the impact of SES in relation to women with diabetes.

There are various factors such as sex and race that influence the association of SES and diabetes. These factors were studied by Robbins et al. by examining different SES variables within different strata of sex and race (2001). It was found that these variables varied with gender and ethnicity of a person. The results of the study strongly suggested that SES has a strong inverse association with diabetes in African-American women and White women but not in men of both ethnicities. A community health survey in Boston found that SES determined by a combination of education and income has a stronger association with the prevalence of diabetes than race or ethnicity (Link & McKinlay, 2009).

d. Education

A low level of formal education remained significantly more common among women with diabetes than among those without diabetes (Beckles & Thompson-Reid, 2002). Years of education was found to be strongly associated with diabetes prevalence among White women, but was not found to be a significant predictor of diabetes prevalence among African-American women (Robbins, Vaccarino, Zhang & Kasl, 2001). These researchers found that with an education of more than 12 years, there was an inverse association with the diabetes prevalence. A 2005 study by Annis and colleagues also suggested a similar finding. Signorello and colleagues also showed that the prevalence of diabetes had an inverse association with educational level in women and that the prevalence was 1.6 times higher in those with less than 9 years of education compared to those who had graduated from college (2007). But a contradictory finding was that education level as a SES factor may be misleading in women and retired population (Robbins, Vaccarino, Zhang, & Kasl, 2001).

e. Income

Income, particularly modeled as PIR, may be a more sensitive indicator of current SES level of an adult. Income is used as a direct measurement of economic wealth as well as major determinant of social prestige in the United States (Liberatos, Link, & Kelsey, 1988). The PIR ratio is based on family size and is the ratio of family income with the family's poverty threshold level (Fryar, Merino, Hirsch, & Porter, 2009). With higher percentages of PIR, the prevalence rates of diabetes decreased as suggested by Annis and colleagues (2005). A study based on NHANES 1999-2002 data suggested that

for ages 65 and above, low income African-Americans were more at risk for poor nutrition and chronic health conditions than Caucasians (Bowman, 2009).

Women with an annual household income of less than $25,000 are twice likely to have diabetes than women who have an annual household income of above $25,000 (Beckles & Thompson-Reid, 2002). Similar results were found in a study by Signorello showing that people with lower income levels had higher prevalence rates of diabetes than higher income levels (2007). However, this study did not found variations in the income-diabetes association when stratified according to gender and race.

2d. Summary

Most studies have shown how diabetes has been linked to different risk factors such as age, ethnicity/race and socioeconomic factors such as income level, PIR and education in women. There are not many studies that linked PD to these risk factors. The same risk factors for diabetes might also have an influence on the prevalence rates of PD in females. Belonging to a certain age, race or SES level might increase the risk for PD. Research has shown that SES variables such as education and income are negatively associated with the prevalence of diabetes.

2e. Theoretical basis of the study

Examination of diabetes risk in women is important for multiple reasons. Using the Life Course Perspective as the theoretical foundation provides rationale for the development of the research questions of this study. This theory considers chronic disease in terms of biological, behavioral, and psychosocial factors that operate across all stages of lifespan to cause or modify disease risk (Aboderin et al., 2002). The Life Course perspective posits that the cumulative burden of risk due to social determinants of health

affects individuals from pre-conception through death. Therefore, women from disadvantaged backgrounds have a greater risk for the development of PD and gradually type 2 diabetes and its complications such as adverse birth outcomes, cardiovascular diseases, increased morbidity, and premature mortality.

Chapter 3 will focus on the methodology used to answer the study research questions.

Chapter III

METHODOLOGY

3a. Data Sources and Study Population

The data for this study came from NHANES 2005-2006. The National Center for Health Statistics conducts the NHANES annually (CDC, 2009). The information gathered from NHANES is meant for health-related research purposes. The NHANES data is a population based survey of the civilian, non-institutionalized U.S population in which participants are interviewed at their homes and then a subset participated in the laboratory examination component (Cowie et al., 2009). This is the only national survey that captures information about diabetes and PD from an interview as well as laboratory measures 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). For this study, data from NHANES 2005-2006 questionnaire, demographic and laboratory files were used.

Self-reported PD status was determined on the basis of how a person answered question number 160 in the questionnaire. The question asked was whether an individual was *ever told by a doctor or professional that she had PD, IFG, IGT, borderline diabetes or was told that blood sugar was higher than normal but not high enough to be diagnosed as diabetes*. Pregnant women were not excluded from the survey. The prevalence rates of self-reported as well as laboratory diagnosed PD (IFG or IGT or A1C) in women 12 years and above were determined in this study. A woman was determined to be prediabetic or not, depending on both self-reported as well as laboratory values.

The 2005 -2006 NHANES laboratory data contains measures such as the OGTT and A1C levels of participants in addition to the fasting blood glucose levels. This helped in assessing the agreement between self-reported and laboratory diagnosed PD using FPG levels. Standard diagnostic criteria were used to determine whether an individual had PD based on IFG, IGT or A1C values. If a person had IFG between 100-125 mg/dl or IGT between 140-199mg/dl or A1C levels between 5.7-6.4% then they were classified as having PD. These laboratory values were as per the recommendations of the American Diabetes Association (2008). If any of these values were above the standard for PD classification, then such cases were excluded from the analysis. The values below these standards were classified as normal.

3b. Study Measures

The study measures that were considered in the study were obtained from the demographic file. These included age, ethnicity, education, family income and poverty income ratio. Any participant who did not have complete information on the demographic characters was eliminated from the study.

Age:

Age was reported as a whole number in years at the time of screening. Age was then classified based on the 2000 Census bureau (CDC, 2002) into four different categories of 12–19 years, 20–39 years, 40-65years and above 65years.

Ethnicity:

Ethnicity was categorized in to the following groups: Hispanic, non Hispanic Whites, non-Hispanic Blacks and other multiracial. Statistical results for the “other multiracial”

are not discussed as there is a wide variation within this group and it cannot be meaningfully interpreted.

SES:

SES was assessed by education, family income and poverty income ratio (PIR). Educational level was self-reported and was categorized into 4 groups: Less than high school, High School Graduate /GED equivalent, Some College, College Grad or more. Family income was classified into four groups, <$20,000, $20,000-44999, $45,000-74999, and >$75,000. The family income and family size was used to calculate the PIR of participants. In this study the PIR was divided into three categories <1.00, 1.00-1.85 and >1.86. This was based on the standards recommended by the US Census Bureau (CDC, 2002).

3c. Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) ^{R} version 17.0 was used to truncate, organize and analyze the data in NHANES 2005-2006 to make it suitable for the study. To achieve sufficient subpopulation representation, NHANES oversampled certain populations (CDC, 2002). To account for any unequal probabilities of selection, over sampling and non-response, appropriate sample weights were utilized for the prevalence estimates. Frequency tables were produced to determine the representation of categorical variables such as age, ethnicity, education, income and PIR of the participants. Frequency tables of self-reported PD as well as IFG, OGT and A1C were also produced. The differences between the mean ages of prediabetic and normal women were determined by an independent t-test for equality of means. The prevalence estimates of PD between different categories of age, ethnicity, education, income and PIR were

performed using the Pearson chi-square test. Univariate and multivariate logistic regression analyses were performed to estimate the factors that were associated with PD. PD (coded as 0 for normal and 1 for PD) was the dependent variable in the models. The independent variables were age, ethnicity, education, family income and PIR. Throughout all the analysis performed, a p value of 0.05 and confidence interval of 95% were used to determine any statistical significance.

Chapter IV

RESULTS

The answers to the research questions are presented in detail in this chapter.

4a. Sample Demographics

The total sample of NHANES respondents that met the study eligibility criteria was 3461 out of which 716 women were found to be prediabetic. The demographic characteristics of the respondents who were included in the study with respect to age, ethnicity, education, income and PIR are presented in Table 1. About 63.9% of the sample was between the ages of 12 and 39. Forty-two percent of the participants identified themselves as non-Hispanic Whites, while both Hispanic and non-Hispanic Blacks each represented about a quarter of the sample, 27.6% and 25.3% respectively Nearly two-thirds of the sample reported having an high school education or less (62.9%). Over half the respondents earned less than$45,000. Majority of the respondents were classified in the upper tertile of the PIR (greater than 1.86%). The mean age of women who had prediabetes was statistically significantly higher than those who had normal blood glucose levels while the PIR means between the two groups were not different (Table 2).

Table 1. Demographic Profile of Female NHANES 2005-2006 Sample (n=3461)

Variables	**N**	**%**
Age		
12-19 years	1148	33.2
20-39 years	1064	30.7
40-59 years	669	19.3
>60years	580	16.8
Ethnicity		
Hispanic	954	27.6
Non-Hispanic Whites	1454	42
Non-Hispanic Blacks	877	25.3
Other	176	5.1
Education		
<High School	1516	43.8
High School Grad/GED	661	19.1
Some College	787	22.7
College Grad or more	493	14.2
Income		
<20,000	861	24.9
$20,000-44,999	1064	30.7
$45000-74,999	708	20.5
>75,000	725	20.9
PIR		
<1	724	20.9
1-1.85	715	20.7
>1.86	1848	53.4

Table 2. Mean Values and Standard Deviations of Continuous Study Variables

Variables	Prediabetic		Normal		p value
	Mean	**SD**	**Mean**	**SD**	
Age	49.02	21.4	31.8	19.23	<0.001
PIR	2.38	0.8	2.33	0.82	0.209

The prevalence of self–reported PD and different categories of laboratory-diagnosed PD is presented in Table 3. The overall estimated prevalence of PD among the participants was 24%. Only 3.8% of the participants reported that a doctor or professional told them that they had PD. IGT prevalence was found to be greater than that of IFG and prediabetic A1C prevalence rates. Among the three laboratory measures, the number of people diagnosed with prediabetes was highest using IGT (13.7%).

Table 3. Percentages of Self-reported PD, IFG, IGT, A1C levels and Total PD (n=3461)

Variables	%
Self-reported PD	3.8
IFG	8.7
IGT	13.7
A1C	11.4
Total PD	24.0

4b. PD and Sociodemographic association

The prevalence of PD significantly increased with age at screening (χ^2 (3) = 392.3, p<0.001). Women who were 60 years and older experienced the highest prevalence (43.10%) followed by those with ages 40-59 years (34.20%). PD rates by ethnicity showed that the prevalence was nearly equal among Hispanics (18.8%), non-Hispanic Whites (20.6%), non-Hispanic Blacks (22.5%), and Other (22.7%). But these

differences were not significant as indicated by the chi square analysis (χ^2 (3) = 4.29, p=0.232). Complete results are shown in Table 4.

Table 4. PD Prevalence by Demographic Variables (n=3461)

Variables	%Prediabetic	p value
Age		
12-19 years	8.7	<.001
20-39 years	12.9	
40-59 years	34.2	
>60years	43.1	
Ethnicity		
Hispanic	18.8	0.232
Non-Hispanic Whites	20.6	
Non-Hispanic Blacks	22.5	
Other	22.7	

Table 5 displays the frequencies and percentages of women who had PD according to different categories of education, family income and PIR. For the first three categories of education, the prevalence of PD increased significantly (χ^2 (3) = 40.61, p<0.001) and then decreased for women who were graduates or had a higher degree. The prevalence of PD among the different categories of income did not vary much (χ^2 (2) = 1.66, p=0.647). The prevalence of PD increased slightly with increasing tertiles of PIR but was not found to be statistically significant (χ^2 (2) = 1.76, p=0.414).

Table 5. PD Prevalence Distribution by SES (n=3461)

Variables	%Prediabetic	p value
Education		
<High School	16.5	<.001
High School	24.8	
Some College	26.6	
College Grad or	18.9	
Income		
<20,000	21.8	0.647
$20,000-44,999	20.5	
$45000-74,999	21.2	
>75,000	19.3	
PIR		
<1	18.9	0.414
1-1.85	20.8	
>1.86	21.3	

The results of univariate analysis of the association between each of the examined independent variables and PD are shown in Table 6. The magnitude of association between the independent variables and outcome variable are quantified using the odds ratio from the logistic regression models. As shown, an increase in age and level of education was associated with increased odds of having PD among women. Ethnicity, family income and PIR were not statistically significantly associated with occurrence of prediabetes among women.

To determine whether the associations in the univariate model were not dependent of other covariates, multivariate logistic regression was performed with different categories of independent variables. PIR was eliminated from multivariate analysis because of its co-linearity with family income.

Table 6. Results of Univariate Analysis of Sociodemographic Factors Associated with PD (n=3461)

Variables	OR	95% CI	p value
Age			
12 - 19 years (Referent)			
20 - 39 years	1.55	1.18 - 2.03	0.002
40 -59 years	5.45	4.21 - 7.07	<.001
>60years	7.94	6.10 - 10.33	<.001
Ethnicity			
Non-Hispanic Whites			
Hispanic	0.89	0.72 - 1.09	0.261
Non-Hispanic Blacks	1.11	0.91 - 1.37	0.296
Other multiracial	1.11	0.78 - 1.65	0.519
Education			
College Grad or more			
Some College	1.56	1.18 - 2.05	0.002
High School Grad/GED	1.42	1.07 - 1.89	0.017
<High School	0.85	0.65 - 1.11	0.224
Income			
>75,000 (Referent)			
$45,000-74,999	0.86	0.67 - 1.10	0.216
$20000-44,999	0.96	0.76 - 1.23	0.756
<20,000	0.92	0.74 - 1.15	0.472
PIR			
>1.86 (Referent)			
1 - 1.85	1.13	0.87 - 1.46	0.363
<1	1.16	0.93 - 1.44	0.187

As illustrated in Table 7, except for family income, all other independent variables were found to be statistically significantly associated with occurrence of prediabetes among women while adjusting for the other 3 variables. Some of the factors that were associated with higher odds of PD were older age, and being a non-Hispanic

Black. It was found that having higher levels of education were associated with higher likelihood of PD adjusting for age, ethnicity and family income.

Table 7. Results of Multivariate Logistic Model for sociodemographic factors associated with PD (n=3357)

Variables	**OR**	**95% CI**	**p value**
Age			
12 - 19 years (Referent)			
20 - 39 years	1.75	1.29 - 2.38	<.001
40 - 59 years	6.65	4.91 - 8.99	<.001
> 60 years	10.80	7.97 - 14.64	<.001
Ethnicity			
Non-Hispanic Whites			
Hispanic	1.69	1.32 - 2.17	<.001
Non-Hispanic Blacks	1.76	1.39 - 2.22	<.001
Other multiracial	1.85	1.22 - 2.81	0.004
Education			
College Grad or more			
Some College	1.85	1.37 - 2.50	<.001
High School Grad/GED	1.63	1.18 - 2.24	0.003
<High School	1.57	1.13 - 2.19	0.008
Income			
>75,000 (Referent)			
$45,000-74,999	0.94	0.71 - 1.25	0.675
$20000-44,999	0.78	0.60 - 1.02	0.068
<20,000	0.91	0.68 - 1.21	0.496

Chapter V

DISCUSSION AND CONCLUSION

5a. Discussion

Early interventions are necessary to prevent the occurrence of diabetes in women by recognizing the risk factors associated with the condition. Early life style changes have been proved to be effective to prevent diabetes development among those who have PD (Diabetes Prevention Program Research Group, 2002). There are studies that have looked at the occurrence of diabetes and sociodemographic factors, but few of them have looked at the association of these risk factors and PD in women. This is particularly important as interventions in women will not only prevent occurrence of type 2 diabetes in the individuals, but may also have an impact on the risk of development of the condition in the offspring.

The study objective was to find the risk factors that are associated with PD occurrence in women using the NHANES 2005-2006 data. NHANES is unique because it represents the US non-institutionalized population. This study also uses self-reported as well as laboratory measures (IFG, IGT and A1C) to determine the prediabetic condition of a woman. NHANES data from 2005-2006 is particularly the best for this study as this was the first year when the glucose tolerance and glycohemoglobin measures were included in the laboratory examination in addition to the fasting glucose measures of the previous years.

The main question of the study was how the prevalence of PD varied among

women in NHANES 2005-2006 sample. The prevalence of self-reported PD was 1.8% less than the total prevalence of PD in a study by Rolka and colleagues (2008). The finding that 24% of the NHANES female participants being identified as prediabetic fell within the range of prevalence rates published by other researchers. For example, the study by Cowie et al found that the prevalence of prediabetes as 29.5% (2009). However this was also based on both genders. In 1988 -1994, the CDC reports that total prevalence of PD (IFG, IGT or both) is 40.1% in the U.S (2008). The unique feature of this study is that in addition to FPG and IGT measures, A1C measures were used as an indicator of PD. Among the measures of PD: self-report, IFG, and IGT and HbA1C—the prevalence of prediabetic cases were highest when IGT was used for determining whether a participant is prediabetic or not. This result is inconsistent with the finding that the prevalence of IFG is higher than IGT (Cowie et al., 2009).

Age consistently emerged as a variable which was strongly associated with PD in women. As age increased, the association also increased. In analyzing the impact of age on the prevalence of PD, the difference in the mean of ages of the prediabetic group was found to be statistically higher than the mean age of the normal group. The peak in prevalence of PD in this study was found to be at age 65 and above. Previous research supports this assertion by reporting the peak prevalence for the condition at age 75 and above (Cowie et al, 2009). The study results reinforce early screening in a woman and education about diet and exercise if one is diagnosed with PD in order to reverse or delay development of type 2 diabetes. Early intervention in women of child bearing age diagnosed with PD will also help to prevent negative outcomes in the offspring.

Non- Hispanic Blacks were associated with a greater likelihood for diabetes than

non-Hispanic Whites in the study which is consistent with the report of MMWR in 2003. However, being Hispanic was found to be protective factor in univariate analysis which was contradictory to the results of multivariate analysis in which being Hispanic was found to increase the likelihood of PD, than being a non-Hispanic White. This can be explained by the discrepancies in the data that matched the type of analysis that was done. The “other racial” group was found to have higher chances than any other ethnic group in multivariate analysis. Since this group could not be clearly defined it was eliminated from the discussion.

Researchers have found that SES is associated with type 2 diabetes in women but not consistently in men (Robbins, Vaccarino, Zhang & Kasl, 2001). Education levels were acknowledged in the literature to be inversely associated with diabetes outcome in White women and not significantly associated in African American women in an NHANES III study (MMWR, 2003). Conversely, in this study it was found that education was significantly but not inversely associated with PD. As the levels of education decreased, it was found that women had lesser likelihood of being prediabetic. However, the interaction of education and PD for different ethnicities was not analyzed.

Results from the logistic regression analyses showed that income and PIR were not significant predictors of PD in women. This result is inconsistent with the findings by other researchers which found that PIR was strongly and inversely associated with diabetes in women (Robbins, Vaccarino, Zhang & Kasl, 2001). One of the reasons for this might be that poor health may affect the income of the individual and not the reverse (Smith, 1999). Education rather than income was found to be associated in women than

income in this study which are not consistent with findings that income was a good indicator of SES than education (Liberatos, Link & Kelsey, 1988).

5b. Limitations of the Study

One limitation of the study is the use of secondary data. Even though, NHANES is a robust and well sampled data set, it provided only few ways of looking at the relationship between demographic characters, SES and PD. A chance of self-report bias is present as variables such as age, education and family income are self-reported in NHANES. Misclassification bias might have occurred when participants were classified into different categories. Also NHANES excluded institutionalized patients who are likely to be older adults. There might be additional variables such as occupation type that would be useful to find the association between SES of women and PD.

5c. Recommendations

Future research that focuses on additional PD risk factors is warranted. Future studies that examine family history of diabetes, obesity, chronic conditions such as blood pressure, use of alcohol and tobacco, access to healthcare which can be potential mediators between sociodemographic characteristics and their association with PD are recommended. It is also important to examine how PD among women and men differ. Studies classifying SES variables by ethnicity might also be able to shed light on how PD varies in different categories of ethnicity among women. The association of type of occupation of women with PD would be helpful in finding which SES variables are strongly related to PD in women. A study on how sociodemographic factors and their association will vary with PD in pregnancy is also recommended.

5d. Conclusion

This study is important because it determines the burden of PD among a national sample of females in the US. Women have unique risks that may vary on the basis of age, ethnicity and education. The results of this study help provide useful insights to public health professionals who are developing upstream health promotion approaches in their attempt to address PD before it advances into diabetes disease**.** The findings of this study have several implications for health of women. The prevalence of PD is higher than the reported prevalence of PD in the US. PD and diabetes are known to complicate pregnancy and cause adverse affects in the prenatal and perinatal life of the offspring. Interventions for prediabetic women of child bearing age (20-39years) might decrease the chance of having PD and also the subsequent development of type 2 diabetes in the mother as well as the offspring. Early screening for PD and lifestyle modifications should be prescribed and practiced particularly in minority women with PD.

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