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Correlation between Self-Appraisal and Measured Risk for Prediabetes

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Correlation between Self-Appraisal and Measured Risk for Prediabetes

by

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Abstract

One-third of adults in the United States have prediabetes and 90% of those individuals are unaware they have the disease. Prediabetes is a disease where blood sugar levels are higher than normal, but not high enough to be diagnosed as prediabetes. The purpose of this thesis was to identify adults at risk for prediabetes in a rural community setting, and explore the relationship between adults' perceived risk for prediabetes and actual measured risk for prediabetes as determined by the Centers for Disease Control (CDC) Prediabetes Screening Test. The organizing framework was based on Betty Neuman's systems model. The participants of this study were adults, aged 18-years, or older who have never been diagnosed by a medical professional as having prediabetes or diabetes. A paired-samples *t*-test was used to determine the correlation between risks for prediabetes as determined an individual's self-appraisal and risk for prediabetes as determined by the CDC's Prediabetes Screening Test. Data analysis revealed a significant difference between self-appraised risk and measured risk for prediabetes. The participants with a prediabetes risk of high as determined by the CDC Prediabetes Screening test were analyzed as a subgroup. Within that subgroup, 55.6% of those participants had self-appraised their risk to be low, and 55.6% of participants could reduce their risk to low with weight loss and/or exercise.

Keywords: prediabetes, diabetes, risk factors, Neuman systems model

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It always seems impossible until it's done. --Nelson Mandela

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CHAPTER I

Correlation between Self-Appraisal and Measured Risk for Prediabetes

Introduction

Prediabetes is defined by the Centers for Disease Control and Prevention (CDC) (2017a) as "a serious health condition where blood sugar levels are higher than normal, but not high enough yet to be diagnosed as diabetes" (para 2). Risk factors for prediabetes include: obesity, age of 45 years or older, having a parent or sibling with type 2 diabetes (T2DM), sedentary lifestyle; gestational diabetes, and giving birth to a baby weighing greater than nine pounds (CDC, 2017a). An estimated 5-10% of individuals with prediabetes will progress to T2DM each year (Tabak, Herder, Rathmann, Brunner, & Mika, 2012).

In 2013, diabetes was the most expensive chronic illness in the United States, with an estimated $101.4 billion spent on healthcare related to diabetes (Dieleman et al., 2016). With the United States healthcare system being the costliest in the world, the Triple Aim Initiative was introduced by the Institute for Healthcare Improvement (IHI) in 2007 (IHI, 2017). The three goals of the Triple Aim are to: improve the patient experience of care; improve the health of populations; and reduce the per capita cost of healthcare (IHI, 2017). By addressing the risk for prediabetes at a community level, small steps toward achieving the goals of the Triple Aim can be made.

Prediabetes often goes undetected until serious health problems occur (CDC, 2017a). For this reason, it is important to address prediabetes at the community level. Education about risk factors and lifestyle choices that can influence risk factors can

empower individuals to make choices that can help delay or prevent prediabetes (Li et al., 2008).

Patient education and health literacy are essential for health and prevention (CDC, 2015), and inefficient health literacy has been associated with poorer health status (Lee, Rhee, Kim, & Aluwalia, 2015). Educating individuals about risk factors and identifying those at risk for diseases, such as prediabetes and diabetes, can help improve the health of populations and reduce cost of healthcare. Knowledge of the prevalence and associated risk factors of prediabetes can raise awareness of the disease and lead to strategies for prevention and management (Akter, Rahman, Abe, & Sultana, 2014).

Significance

One-third of adults in the United States have prediabetes (CDC, 2017a). Of those with prediabetes, up to 70% will develop T2DM (Tabak et al., 2012). Diabetes is the costliest chronic illness to the United States economy (Dieleman et al., 2016), and was the seventh leading cause of death in 2014 (Heron, 2013). The American Diabetes Association (ADA) reports that individuals with diagnosed diabetes incur about $13,700 in medical expenditures each year. Of that $13,700, approximately $7,900 is associated with diabetes (ADA, 2015). Additionally, diabetes can result in reduced productivity such as increased absenteeism, inability to work due to disability, and lost productive capacity due to early mortality (ADA, 2015).

In 2011, a diabetes belt was identified in the United States. This belt consists of 644 counties in 15 mostly southern states (Barker, Kirtland, Gregg, & Thompson, 2011). Within the diabetes belt, 11.7% of individuals have diagnosed diabetes, compared with a

national average of 8.5% (Barker et al., 2011). More recent data reveals the national average of diabetes is now 9.3% (CDC, 2014).

North Carolina is one of the states identified in the 2011 diabetes belt (Barker et al., 2011). Ninety-three of North Carolina's 100 counties have a higher prevalence of diabetes than the national average (CDC, 2013). Cleveland County ranks 51 out of 100 in diabetes prevalence in North Carolina with 12.4% of residents having diagnosed diabetes (CDC, 2013).

The CDC (2017a) reported that prediabetes is reversible, and the progression to T2DM can be prevented or delayed with lifestyle changes. Obesity and inactivity account for one-third of the risk for diabetes (Barker et al., 2011). Ninety percent of individuals with prediabetes are not aware of their condition (CDC, 2017a). One key to decreasing the prevalence of diabetes is to identify those with prediabetes, and those at risk for prediabetes, so that lifestyle modifications can be made to prevent the progression to T2DM (ADA, 2016a).

Problem Statement

One-third of adults in the United States have prediabetes. Furthermore, 90% of those with prediabetes are unaware that they have it, and 40% of those actually at risk for prediabetes perceive they are at no risk for developing prediabetes or diabetes (ADA, 2013). Many individuals are also unaware of the actual risk factors for prediabetes and the significance of modifiable risk factors in the prevention of prediabetes (Akter et al., 2014). Lifestyle modifications, such as weight loss and exercise, can reverse prediabetes and prevent or delay the progression to T2DM (ADA, 2016a). Use of a prediabetes screening tool, such as the CDC Prediabetes Screening Test, can identify individuals at

high risk for prediabetes, and can also help individuals identify which lifestyle modifications can be effective in reducing their risk for prediabetes (Poltavskiy, Kim, & Bang, 2016). Individuals at risk for prediabetes need to be identified so that appropriate education and lifestyle modifications can be addressed.

Purpose

The purpose of this Master of Science in Nursing (MSN) thesis was to identify adults at risk for prediabetes and explore the relationship between adults' perceived risk for prediabetes and actual measured risk for prediabetes as determined by the CDC Prediabetes Screening Test.

Theoretical Framework

Betty Neuman's systems model is the theoretical framework that will be used to guide this study of adults' perceived risk of prediabetes and actual measured risk of prediabetes as determined by the CDC Prediabetes Screening Test. The Neuman systems model describes five variables that make up the client system: physiological, psychological, sociocultural, developmental, and spiritual (Neuman, 1995). These five variables are independently as important as the other, and each variable is crucial for keeping the patient at optimal health. When one variable is threatened, all the other variables are at risk (Neuman, 1995).

To protect the five variables, there are lines of defense and lines of resistance. In the innermost center are the energy resources and basic structures needed for survival. The farthest from the center is the flexible line of defense. This is a forgiving line that serves as a buffer for the less flexible normal line of defense. The normal line of defense is the patient's wellness baseline. Once the baseline is compromised, the lines of

resistance are exposed. This causes one or more of the five variables (physiological, psychological, sociocultural, developmental, and spiritual) to be compromised and symptoms are exhibited. If the lines of resistance are not effective in protecting the basic structure, illness and/or death may occur (Neuman, 1995).

All five variables of the Neuman systems model (physiological, psychological, sociocultural, developmental, and spiritual) can be affected by prediabetes and diabetes. Physiological impacts of prediabetes include heart disease and stroke, blindness, kidney disease, and loss of limbs (CDC, 2014). An example of a psychological impact related to prediabetes and diabetes is depression related to health-related quality of life (Alenzi & Sambamoorthi, 2016). The sociocultural variable can be influenced by an individual's loss of work productivity as evidenced by increased absenteeism, inability to work due to disability, and lost wages (ADA, 2015). Prediabetes and diabetes can affect the developmental variable by increasing mortality (Heron, 2013). The fifth variable, spirituality, can be affected as individuals with diabetes cope with and manage their illness (Namageyo-Funa, Muilenburg, & Wilson, 2015).

By identifying individuals at risk for prediabetes and modifiable risk factors that could reduce risk for individuals, efforts can be made to strengthen lines of defense and prevent penetration of the client system. Stronger lines of defense will prevent or delay the development of prediabetes and further progression to T2DM (see Figure 1).

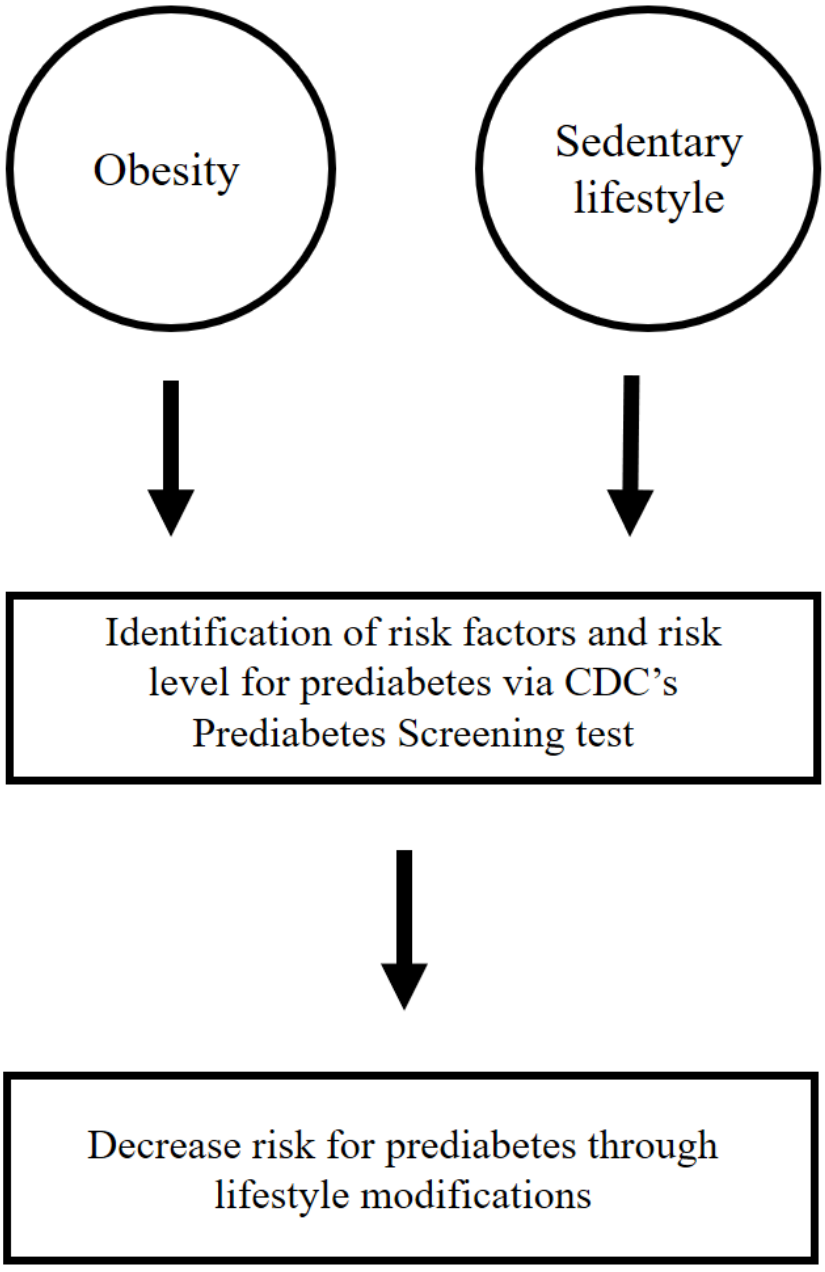

Figure 1. Identification of risk for prediabetes and modifiable risk factors, allowing for lifestyle modifications to prevent development of prediabetes and/or progression to T2DM using the Neuman systems model.

Research Question and Hypothesis

The research question for this correlational study was: Is an individual's self-appraised risk for prediabetes associated with the individual's actual risk for prediabetes, as measured by the CDC's Prediabetes Screening Test? The researcher's hypothesis was that the self-appraisal of risk for prediabetes would be lower than the measured risk for prediabetes.

Definition of Terms

Prediabetes is defined by the CDC (2017a) as "a serious health condition where blood sugar levels are higher than normal, but not high enough yet to be diagnosed as diabetes" (para 2). Prediabetes can be diagnosed with an A1C level of 5.7-6.4 percent (ADA, 2016b). Diabetes is defined by the CDC (2014) as "a group of diseases marked by high levels of blood glucose resulting from problems in how insulin is produced, how insulin works, or both" (p. 8). Diabetes can be diagnosed with an A1C level of 6.5% or higher (ADA, 2016b). A1C is a blood test that provides information about an individual's average blood sugar over the past three months (National Institute of Diabetes and Digestive and Kidney Diseases, 2014).

Overweight is defined by the World Health Organization (WHO, 2016a) as having a body mass index of 25 or higher. Obesity is defined by the WHO as a body mass index of 30 or higher (2016a). Physically active is defined by the WHO as participating in 150 minutes of moderate-intensity physical activity per week, or 75 minutes of vigorous-intensity physical per week (WHO, 2016b).

CHAPTER II

Literature Review

Prediabetes is a health condition where blood sugar levels are higher than normal, but not high enough to be diagnosed as T2DM (CDC, 2017a). Ninety percent of individuals in the United States who have prediabetes are unaware that they have it (CDC, 2017a). Additionally, many individuals with prediabetes, or those at risk for prediabetes, are unaware of the actual risk factors for prediabetes and the significance of modifiable risk factors in the prevention of prediabetes (Akter et al., 2014).

Risk factors for prediabetes include: obesity, age of 45 years or older, having a parent or sibling with T2DM, sedentary lifestyle, gestational diabetes, and giving birth to a baby weighing greater than nine pounds (CDC, 2017a). Lifestyle modifications, such as weight loss and exercise, can reverse prediabetes and prevent or delay the progression to T2DM (ADA, 2016a). While age, birth weight of babies, and family history cannot be modified, weight and activity can be modified.

The purpose of this thesis was to identify adults at risk for prediabetes and explore the relationship between adults' perceived risk for prediabetes and actual measured risk for prediabetes as determined by the CDC Prediabetes Screening Test. The CDC Prediabetes Screening Test uses the following criteria to identify risk for prediabetes: women giving birth to a baby weighing greater than nine pounds; having a sibling or parent with diabetes; body mass index of 27 or greater; sedentary lifestyle; and age (CDC, 2017b).

Prediabetes often goes undetected until serious health problems occur (CDC, 2017a). Identifying prediabetes and educating individuals about their risk for prediabetes

at a community level can help empower individuals to make lifestyle changes before serious health problems develop. Educating individuals at the community level about risk factors for prediabetes can help improve the health of populations and reduce the cost of healthcare, leading to increased awareness of prediabetes and increased strategies for prevention and management (Akter et al., 2014).

Review of Literature

A literature review was conducted to reveal data related to the modifiable risk factors for prediabetes and the risk prediabetes predisposes upon other disease processes. Research related to the Neuman systems model was also conducted as this model will be used as the theoretical framework to guide this thesis. The sources used for the literature review were Medical Literature Analysis and Retrieval System Online (MEDLINE) and Cumulative Index for Nursing and Allied Health Literature (CINHAL). Keywords were: prediabetes; diabetes; risk factors; and Neuman systems model.

Literature Related to Statement of Purpose

Risk for Developing Morbidities

A study by Brunisholz et al. (2016) supported the idea that individuals with prediabetes are at an increased risk of developing T2DM. A longitudinal, closed cohort design was used to determine the association of prediabetes and its progression to T2DM over a five-year period. Groups considered were individuals with unconfirmed prediabetes, individuals with confirmed prediabetes, and at-risk individuals. Data was used from the Intermountain Healthcare Enterprise Data Warehouse. Findings included the strong association of individuals with confirmed and unconfirmed prediabetes and the development of T2DM as compared to individuals with only risk factors for T2DM.

Within the five-year period, 20% of the confirmed prediabetes groups had converted to T2DM, which supports other literature in the progression of prediabetes to T2DM (Brunisholz et al., 2016).

Progression from prediabetes to diabetes was also examined by Kim et al. (2016). The use of hemoglobin A1C and fasting plasma glucose to predict the five-year progression rate to diabetes was examined in a longitudinal study of 17,971 Koreans. The progression rate to diabetes from prediabetes was more accurately identified using hemoglobin A1C than by fasting blood glucose. The study clarified that fasting plasma glucose can be used to identify those at risk for prediabetes, however hemoglobin A1C more accurately detects prediabetes in individuals (Kim et al., 2016).

Abbasi, Kohli, Reaven, and Knowles (2016) identified a relationship between insulin resistance and increased risk for developing T2DM and coronary heart disease. The cross-sectional study consisted of 587 individuals who were classified by fasting glucose levels as having prediabetes or not having prediabetes. Elevated triglyceride levels in the prediabetes population identified a subset of individuals who had higher coronary disease risk profiles than individuals with normal glucose levels. A limitation to the study was the sole use of fasting glucose levels to diagnose prediabetes. Using a glucose tolerance test instead or fasting glucose test may have resulted in individuals being classified differently, or found to have T2DM (Abbasi et al., 2016).

Many individuals undergoing elective percutaneous coronary intervention (PCI) can be identified as having new diabetes, prediabetes, and/or metabolic syndrome (Balakrishnan et al., 2015). Data were collected from 740 patients undergoing elective PCI at New York University Langone Medical Center. Thirty nine percent of individuals

undergoing PCI had known diabetes. Of those without diagnosed diabetes, 8.3% met criteria for diabetes and 58.5% met criteria for prediabetes. Including all participants, 54.9% met criteria for metabolic syndrome. This study identified the need for routine screening for diabetes, prediabetes, and/or metabolic syndrome in individuals undergoing PCI (Balakrishnan et al., 2015).

The association between prediabetes and risk of chronic kidney disease was explored by Echouffo-Tcheugui, Narayan, Weisman, Golden, and Jaar (2016). A meta-analysis was conducted of nine cohort studies that reported a relationship of prediabetes to chronic kidney disease. The Meta-analysis Of Observational Studies in Epidemiology (MOOSE) was used in guiding the review. The study revealed a modest association of prediabetes and increased risk of chronic kidney disease. Publication bias could not be completely excluded. However, the study did indicate the importance of screening for chronic kidney disease in patients with prediabetes and aggressively managing prediabetes in patients with diagnosed chronic kidney disease (Echouffo-Tcheugui et al., 2016).

Prediabetes Screening Assessments

The diabetes screening tools provided by the American Diabetes Association (ADA) and the Centers for Disease Control and Prevention (CDC) were evaluated and compared by Poltavski et al. (2016). Data from the National Health and Nutrition Examination Survey (NHANES) 2009-2012 was used to evaluate the risk of prediabetes and diabetes in 9,391 individuals. The same screening tools, but with different cut points were used for diabetes and prediabetes. Individuals with diagnosed diabetes, undiagnosed diabetes, and diagnosed prediabetes were excluded. Both ADA and CDC

scores performed comparatively and robustly. This study identified the use of the ADA and CDC diabetes and prediabetes screening tools as reliable, cheap, and easy ways for individuals to assess their risk and identify modifiable risk factors that could reverse prediabetes or delay progression to diabetes (Poltavskiy et al., 2016).

The use of the CDC Prediabetes Screening Test was examined in a cross-sectional study by James, Matasangas, and Connelly (2016). Participants were 70 overweight or obese individuals attending a weight loss clinic in Southern California. All participants were identified as high risk for prediabetes by the CDC Prediabetes Screening Test. Hemoglobin A1C identified that 70.5% of the participants were actually prediabetic. Participants were then provided with consultations regarding their risk for prediabetes and diabetes. After a four-month period, participants had lost 6-30 pounds, had reductions in hemoglobin A1C levels, and had increased activity levels. The CDC Prediabetes Screening test was felt to have overestimated the risk for pre-diabetes in participants, however it was identified as a non-threatening approach to assessing risk and initiating discussions related to obesity and diabetes risk (James et al., 2016).

Many criteria used in the CDC Prediabetes Screening Test were used to predict prediabetes in a study done by Heikes, Eddy, Arondekar, and Schlessinger (2008). Data from the NHANES 1999-2004 was used to screen individuals for prediabetes and diabetes using age, waist circumference, gestational diabetes, height, race/ethnicity, hypertension, family history, and exercise. Of the 7,092 individuals, 4.16% were found to have undiagnosed diabetes and 26.14% were found to have undiagnosed prediabetes. This study provided an inexpensive and easy screening tool that could be self-

administered to assess an individual's risk for prediabetes and diabetes (Heikes et al., 2008).

Modifiable Risk Factors

Obesity. Haider and Ziyab (2016) looked specifically at obesity as a risk factor for prediabetes. A cross-sectional study was conducted among 934 college students attending college in Kuwait. The participants did not have diagnosed prediabetes. Height and weight measurements were used to calculate body mass index and hemoglobin A1C was used to determine the diagnosis of prediabetes. The association between obesity and prediabetes was found to be statistically significant with the majority of individuals having prediabetes being obese (Haider & Ziyab, 2016).

Abdominal obesity, low high-density lipoprotein cholesterol (HDL), and hypertension were found to be independent risk factors for prediabetes by Diaz-Redondo et al. (2015). A cross-sectional analysis of individuals classified as having prediabetes or glucose metabolism disorders was conducted. Modifiable risk factors evaluated were smoking, alcohol consumption, low physical activity, inadequate diet, hypertension, dyslipidemia, abdominal obesity, and general obesity. Abdominal obesity exhibited the strongest association with prediabetes in men and women. Risky alcohol consumption was found to be a risk factor for prediabetes in men, but not in women. General obesity was found to be a risk factor for prediabetes in women, but did not reach statistical significance for men. Differences between men and women were identified, emphasizing the need for implementing gender-specific recommendations to prevent prediabetes (Diaz-Redondo et al., 2015).

Abdominal obesity in healthy-weight individuals was analyzed as a risk factor for prediabetes by Mainous, Tanner, Jo, and Anton (2016). The NHANES was analyzed with a focus on adults who had body mass indexes of 18.5-34.99 and did not have diabetes. Among adults with normal glucose levels and adults with prediabetes, abdominal obesity was not found to be an independent predictor of prediabetes. Both the prevalence of prediabetes and abdominal obesity increased from 1988-1994 to 2012, however the two factors were not found to be associated (Mainous et al, 2016).

Diet. Kollannor-Samuel, Shebl, Hawley, and Perez-Escamilla (2016) explored the use of food labels on diet quality in individuals with undiagnosed prediabetes. A secondary data analysis of cross-sectional data from adults in the United States with undiagnosed prediabetes was used. The four categories of food label usage included: use of nutrition facts and health claims, use of health claims only, use of no label, and use of nutrition facts panel only. Use of nutrition facts panel alone was associated with higher diet quality and glucose control than other groups (Kollanor-Samuel et al. 2016).

Individuals who consume sugar-sweetened beverages are more likely to develop prediabetes, according to a prospective cohort study by Ma et al. (2016). Study participants were middle-aged adults from the Framingham Heart Study's Offspring cohort who had not been diagnosed as having prediabetes or diabetes at baseline. The highest sugar-sweetened beverage consumers had a 46% higher risk of developing prediabetes than those who did not consume sugar-sweetened beverages. Consumption of diet soda was not associated with development of prediabetes (Ma et al., 2016).

Weight loss and exercise. A decrease in insulin resistance in individuals who participated in a resistance training program was identified by Eikenberg et al. (2016).

Participants were adults aged 50-69 years who were identified as at risk for prediabetes. After a 12-week resistance training program, two-hour oral glucose tolerance tests were lower. However, fasting glucose concentrations were unchanged. The study did not address the impact of diet or non-resistance physical activity on glucose levels. Limitations of the study were the absence of control groups and hemoglobin A1C was not measured in participants (Eikenberg et al., 2016).

Individuals with prediabetes who initiate exercise were found to be unlikely to develop and maintain a regular exercise program by Kuo et al. (2014). A grounded theory study was conducted in a medical center in Taiwan and included 20 participants with prediabetes. Participants were interviewed and asked about exercise motivations and obstacles. Most individuals failed to develop and maintain routine exercise. A conclusion of the study was that health professionals should assess the psychological needs of individuals with prediabetes, to improve the intrinsic motivation toward exercise, before providing them with exercise interventions (Kuo et al., 2014).

A randomized intervention trial by Marrero et al. (2016) found that lifestyle changes associated with diabetes prevention are more likely to be achieved through a weight management program, such as Weight Watchers, than through self-initiated and self-regulated weight loss and activity programs. This study was conducted in Indianapolis, Indiana in 2013-2014, and included 225 individuals who had been diagnosed with prediabetes. Individuals who participated in Weight Watchers lost 5.5% of weight at six-month and 12-month markers. Individuals who participated in self-initiated and self-regulated weight loss and activity programs lost 0.8% of weight at six months and had nearly reverted to their baseline weight at 12 months with a 0.2% weight

loss. Limitations of the study included loss of participants during the course of the study and the majority of the participants were women. Another observation was that weight management programs, such as Weight Watchers, have monthly fees and may not be utilized by some individuals due to cost (Marrero et al., 2016).

A community based approach to lifestyle modifications in individuals with prediabetes was documented by Ibrahim, Ming, Awalludin, Mohd, and Ismail (2016). A quasi-experimental study was conducted among 268 individuals in two sub-urban communities in Malaysia. Participants with diagnosed diabetes were assigned to either a community-based lifestyle intervention (Co-HELP) group, or a usual care group. After one year, Co-HELP participants had decreased fasting blood sugar, decreased two-hour post glucose, decreased hemoglobin A1C, decreased diastolic blood pressure, decreased waist circumference, and increased HDL cholesterol when compared with the control group. The study suggested that a culturally adapted diabetes prevention program can benefit individuals in a community setting by reducing modifiable risk factors (Ibrahim et al., 2016).

Literature Related to Theoretical Framework

The Neuman systems model was used as a framework in examining the relationship between perceived stress and wellness in early adolescents by Yarcheski, Mahon, Yarcheski, and Hanks (2010). A cross-sectional, correlational design was used to analyze the perceived relationship between perceived stress and wellness in 144 adolescents, aged 12-14 years. The Wellness Factor of the Laffrey Health Conception Scale, the Perceived Stress Scale, and the Primary Appraisal Scale were used measure

perceived stress and wellness. Perceived stress was found to be negatively associated with wellness (Yarcheski et al., 2010).

The Neuman systems model was also used to guide research by Smith-Johnson, Davis, Burns, Montgomery, and McGee (2015). A quantitative design was used to explore perceived stress of African American wives in the care of spouses who were stroke survivors. The participants were from rural communities in South-East North Carolina. Pearlin's Caregiving and Stress Process tool was used to measure stressful situations. Three-fourths of participants were identified as being in high-stress situations. The study was limited by sample size. The study indicated a need for improved patient and family education, both on an inpatient and outpatient level, including importance of rehabilitation and availability of community support (Smith-Johnson et al., 2015).

The relationship of spirituality to health status in adults living with HIV/AIDS was explored using the Neuman systems model by Cobb (2012). A model building approach was used to explore the associations among all five variables of the Neuman systems model, but spirituality was the primary relationship examined. Participants were a convenience sample of 39 adults who were recruited from a major mid-Atlantic university medical center. Significant relationships were found between dependent physiological variables and independent spiritual variables. Spirituality was found to be an essential contributor to health status in individuals living with HIV. This study indicated a need for further research to test the relationship of spirituality and health status on larger scales with more diverse samples, and possibly in longitudinal studies (Cobb, 2012).

Strengths and Limitations of Literature

There is an abundance of research linking modifiable risk factors, such as obesity and sedentary lifestyle, with prediabetes. The research also supports that decreasing weight and increasing activity can impede prediabetes and/or T2DM. No research was found that evaluated the relationship of the self-appraised risk for prediabetes in relation to actual risk for prediabetes.

CHAPTER III

Methodology

Prediabetes is a health condition where blood sugar levels are higher than normal, but not high enough to be diagnosed as T2DM (CDC, 2017a). Risk factors for prediabetes include: obesity, age of 45 years or older, having a parent or sibling with T2DM, sedentary lifestyle, gestational diabetes, and giving birth to a baby weighing greater than nine pounds (CDC, 2017a). Many individuals with prediabetes, or those at risk for prediabetes, are unaware of the actual risk factors for prediabetes and the significance of modifiable risk factors in the prevention of prediabetes (Akter et al., 2014).

Prediabetes often goes undetected until serious health problems occur (CDC, 2017a). Individuals with prediabetes are at an increased risk for developing morbidities such as diabetes (CDC, 2017a; Abbasi et al., 2016; Kim et al., 2016), coronary artery disease (Balakrishnan et al., 2015) and kidney disease (Echouffo-Tcheugui et al., 2016). The CDC Prediabetes Screening Test is an inexpensive and easy way to identify individuals at risk for prediabetes and educate those individuals about risk factors for prediabetes (James et al., 2016; Poltavskiy et al., 2016).

With diabetes being the most expensive chronic illness in the United States (Dieleman et al., 2016), addressing prediabetes at the community level can help identify those at risk so that lifestyle modifications can be made to delay or prevent prediabetes and its progression to diabetes. Knowledge of the prevalence and associated risk factors of prediabetes can raise awareness of the disease and lead to strategies for prevention and management (Akter et al., 2014).

The purpose of this thesis was to identify adults at risk for prediabetes and explore the relationship between adults' perceived risk for prediabetes and actual measured risk for prediabetes as determined by the CDC Prediabetes Screening Test. The CDC Prediabetes Screening Test uses the following criteria to identify risk for prediabetes: women giving birth to a baby weighing greater than nine pounds, having a sibling or parent with diabetes, body mass index of 27 or greater, sedentary lifestyle, and age (CDC, 2017b).

Study Design

This was a quantitative correlational study to explore the relationship between adults' perceived risk for prediabetes and actual measured risk for prediabetes as determined by the CDC Prediabetes Screening Test. Data was further explored for correlations between variables.

Setting and Sample

A rural church in western North Carolina was the setting for this study to explore the relationship between adults' perceived risk for prediabetes and actual measured risk for prediabetes as determined by the CDC Prediabetes Screening Test. At the time of the study, the church had an average of 125 in attendance on Sunday mornings. No education about prediabetes had taken place at the church prior to the study. Individuals who had been diagnosed by a medical professional as having diabetes or prediabetes were excluded.

A convenience sample was used of willing adults, age 18 and older, who attended Sunday School on one particular Sunday morning. The number of participants was 31.

Permission for this study was obtained from the Pastor and Chairman of Deacons of the church (see Appendix A). Approval was also obtained from the Institutional Review Board of the University.

Design for Data Collection

Before collecting the data, the purpose of the study was explained to potential participants. The purpose of the study was to identify adults at risk for prediabetes and explore the relationship between adults' perceived risk for prediabetes and actual measured risk for prediabetes as determined by the CDC Prediabetes Screening Test. Participants were informed that to participate they should be 18-years or older and have never been diagnosed by a medical professional with diabetes or prediabetes. After informing potential participants of the purpose and requirements to participate, those who wished not to proceed were given an opportunity to exclude themselves.

Participants were given a consent form to read and sign (see Appendix B). After completed, the consent forms were collected and consenting participants were given a numbered questionnaire that asked them to rate their perceived risk for prediabetes: Low or high (see Appendix C). Once completed, this questionnaire was collected by the researcher. The CDC Prediabetes Screening Test (see Appendix D), numbered correspondingly to the self-appraisal, was then given to the participants. The CDC Prediabetes Screening Test had questions related to the following: Women having a baby with a birthweight of greater than nine pounds, having a sibling with diabetes, having a parent with diabetes, weight, and age. Participants were asked to complete the self-assessment. Guidance in completing the assessment was offered by the researcher for those who had questions or problems understanding the assessment. Once completed, the

survey was collected from participants and secured in an envelope. The signed consents and all data were kept by the researcher and secured in a locked file inside of a locked room, to which only the researcher has a key. Participants were given a copy of the informed consent, the CDC Prediabetes Screening Test, and an educational prediabetes handout (see Appendix E) to keep. The CDC Prediabetes Screening Test also included information about reducing risk for prediabetes and information about access to healthcare for those wanting to follow-up with their medial provider about their prediabetes risk.

Measurement Methods

The CDC Prediabetes Screening Test was used to measure prediabetes risk for participants. The CDC Prediabetes Screening Test is available to the public by the CDC at www.cdc.gov/diaetes/prevention/pdf/prediabetestest.pdf. This test has been used in other research and has been determined to be reliable and efficient in predicting prediabetes risk for individuals (James et al., 2016; Poltavskiy et al., 2016).

Protection of Human Subjects

Informed consent was obtained from each participant prior to the collection of data. Anonymity of each participant was ensured by excluding any identifiers from the self-assessment and the CDC Prediabetes Screening Test. Ethical considerations addressed in the development of this study included the possibility of participants feeling that they do not need to be compliant with their primary care provider's recommendations for other medical conditions if their risk for prediabetes is low. For those whose risk for prediabetes is high, they may feel there is no need to try to prevent the impending disease. To prevent these issues, information about prediabetes and

decreasing risk for prediabetes through lifestyle modifications was provided to participants.

Another ethical consideration was participants who have high risk for prediabetes, but may not have a primary care provider or health insurance. Contact information for the health department will be provided for participants who do not have a primary care physician or health insurance. The second page of the CDC Prediabetes Screening Test offered information for individuals about lifestyle modifications and the importance of regular healthcare follow-up.

Permission to conduct this study was obtained from the Pastor and Chairman of Deacons at the church. Approval was also obtained from the University's Institutional Review Board.

Data Analysis

Data was entered by the researcher in a personal computer and analyzed using Statistical Package for the Social Sciences (SPSS) version 24. A paired-samples *t*-test was used to compare perceived risk for prediabetes and actual measured risk for prediabetes as determined by the CDC Prediabetes Screening Test. The participants with a prediabetes risk of high as determined by the CDC Prediabetes Screening test were analyzed as a subgroup to compare perceived risk for prediabetes and actual measured risk for prediabetes.

CHAPTER IV

Results

The purpose of this thesis was to identify adults at risk for prediabetes and explore the relationship between adults' perceived risk for prediabetes and actual measured risk for prediabetes as determined by the CDC Prediabetes Screening Test. The research question for this correlational study was: Is an individual's self-appraised risk for prediabetes associated with the individual's actual risk for prediabetes, as measured by the CDC's Prediabetes Screening Test? The researcher's hypothesis was that the self-appraisal of risk for prediabetes would be lower than the measured risk for prediabetes.

Sample Characteristics

The self-appraisal and the CDC Prediabetes Screening Test were distributed to a convenience sample of adults attending Sunday School at church in western North Carolina. Inclusion criteria were adults (aged 18-years, or older) and having never been diagnosed by a medical professional with prediabetes or diabetes. Of potential participants, five either did not qualify or chose not to participate. A total of 31 completed surveys were returned. The answers to each question on the CDC Prediabetes Screening Test are shown in Table 1. The results of the CDC Prediabetes Screening Tests and the self-appraisals are shown in Table 2.

Figure 2 illustrates how individuals rated their perceived risk for prediabetes versus their actual measured risk for prediabetes as determined by the CDC Prediabetes Screening Test. Individuals rating their risk of prediabetes as high on the self-appraisal was 32.26%; whereas 58.01% of individuals were determined by the CDC Prediabetes Screening Test to have a high risk of developing prediabetes.

Table 1

CDC Prediabetes Screening Test Answers

Question	All participants (N=31)	Yes	No
Woman having baby weighing >9 lbs.		4	27
Sibling with diabetes		2	29
Parent with diabetes		12	19
At-risk weight		18	13
<65 years with little or no exercise		8	23
Between 45-65 years		12	19
>65 years		8	23

Table 2

Self-appraisal for Prediabetes vs. Measured Risk for Prediabetes as Determined by the CDC Prediabetes Screening Test

Measure	All participants (N=31)	Low	High
Prediabetes self-appraisal		21	10
Actual measured risk		13	18

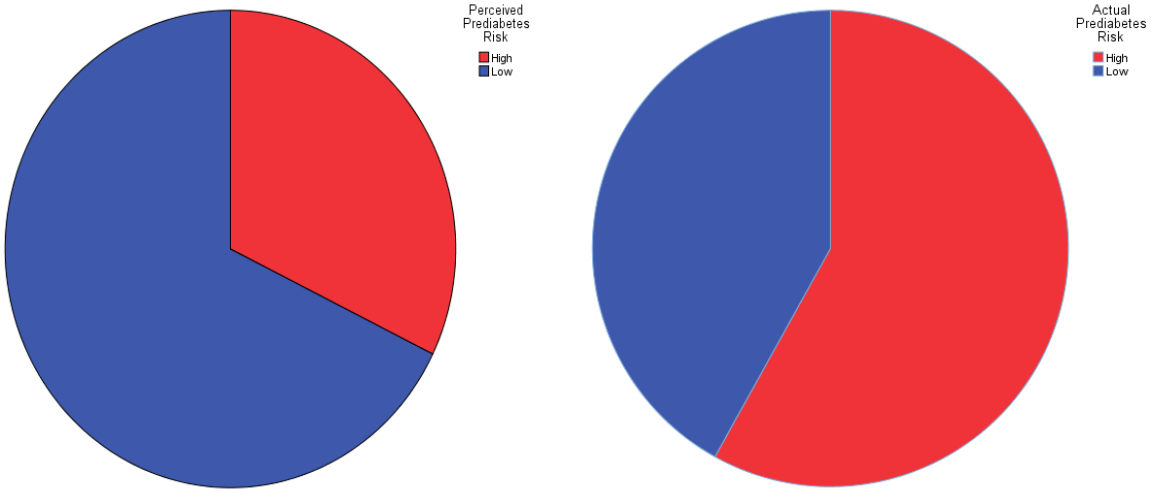

Figure 2. Perceived Prediabetes Risk and Actual Prediabetes Risk

Major Findings

The sample consisted of 31 individuals aged 18-years or older. A paired-samples *t*-test was conducted to determine the association of risk for prediabetes as determined by an individual's self-appraisal and risk for prediabetes as determined by the CDC's Prediabetes Screening Test. There was a significant difference in the scores for perceived prediabetes risk (M = 1.32, SD = .475) and measured prediabetes risk (M = 1.58, SD = .502); t(30) = -2.278, p = .030 (see Table 3).

There were 18 out of the 31 individuals who had a high risk for prediabetes as determined by the CDC Prediabetes Screening Test. These samples were divided into a subgroup and analyzed. Only 10 of those individuals had self-appraised their risk as high. Again, a paired-samples *t*-test was conducted in this subgroup to determine the association of risk for prediabetes as determined by an individual's self-appraisal and risk for prediabetes as determined by the CDC's Prediabetes Screening Test. There was a significant difference in the scores for perceived prediabetes risk (M = 1.39, SD = .502)

and measured prediabetes risk (M = 2.00, SD = .000); t(17) = -5.169, p = .000 (see Table 4).

Analyzation of the subgroup of individuals with high measured risk of prediabetes also revealed that 55.6% of individuals could decrease their risk from high to low with weight loss and/or exercise. Weight loss and exercise were the only two modifiable risk factors addressed in the CDC Prediabetes Screening Test.

Table 3

Correlation of Individual's Self-appraised Risk for Prediabetes with Measured Risk for Prediabetes as Determined by the CDC Prediabetes Screening Test.

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1 Perceived Prediabetes Risk- Actual Prediabetes Risk	-.258	.631	.113	-.489	-.027	-2.278	30	.030

Table 4

Subgroup of Individuals with a Score of High on the CDC Prediabetes Screening Test. Correlation of Those Individual's Self-appraised Risk for Prediabetes with Measured Risk for Prediabetes as Determined by the CDC Prediabetes Screening Test.

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1 Perceived Prediabetes Risk- Actual Prediabetes Risk	-.611	.502	.118	-.861	-.362	-5.169	17	.000

Summary

This quantitative correlational study explored the relationship between adults' perceived risk for prediabetes and actual measured risk for prediabetes as determined by the CDC Prediabetes Screening Test. There was a total of 31 participants. The study revealed that, in general, a significant number of individuals (45.2%) were unaware of their actual risk for prediabetes. The study also found that a significant number of individuals at a measured high risk for prediabetes (55.6%) underestimated their prediabetes risk, and that over half of individuals with a measured high risk of prediabetes (55.6%) could lower their risk from high to low with weight loss and/or exercise.

CHAPTER V

Discussion

Implication of Findings

The purpose of this thesis was to identify adults at risk for prediabetes and explore the relationship between adults' perceived risk for prediabetes and actual measured risk for prediabetes as determined by the CDC Prediabetes Screening Test. The data analysis revealed a significant difference between self-appraised risk and measured risk for prediabetes.

Also significant, was individuals underestimating their risk for prediabetes. Of participants with a high risk of prediabetes as determined by the CDC Prediabetes Screening Test, 55.6% self-appraised their risk for prediabetes as low. The ADA reports that 40% of individuals at risk for prediabetes perceive they are at no risk for developing prediabetes or diabetes (ADA, 2013). The number of participants underestimating their risk in this study was higher than the number reported by the ADA. The fact that the population in this study had a higher percentage of individuals underestimating their prediabetes risk exposes a significant need for prediabetes education in this population.

The study also revealed that over half of participants could change their risk for prediabetes from high to low with weight loss and/or exercise. Knowledge of the impact of these modifiable risk factors could empower individuals to make lifestyle changes to reduce their risk for prediabetes. Prediabetes education at the community level can help pull individuals together to learn about risks for prediabetes. Fostering community education and involvement could also encourage the formation of exercise or weight management groups that could address lowering prediabetes risk.

Application to Theoretical/Conceptual Framework

Betty Neuman's systems model was the theoretical framework used to guide this study of adult's perceived risk of prediabetes and actual measured risk of prediabetes as determined by the CDC Prediabetes Screening Test. The Neuman systems model describes five variables that make up the client system: physiological, psychological, sociocultural, developmental, and spiritual (Neuman, 1995). Each of the five variables are independently as important as the other, and each variable is crucial for keeping the patient at optimal health. When one variable is threatened, all the other variables become vulnerable (Neuman, 1995).

Protecting the five variables are lines of defense and lines of resistance. In the innermost center are the energy resources and basic structures needed for survival. The farthest from the center is the flexible line of defense, serving as a buffer for the less flexible normal line of defense. The normal line of defense is the patient's wellness baseline. Once this line of defense is interrupted, by such as prediabetes, the lines of resistance are exposed. This causes one or more of the five variables to be compromised and symptoms are exhibited. If the lines of resistance are not effective in protecting the basic structure, illness and/or death may occur (Neuman, 1995).

All five variables of the Neuman systems model can be affected by prediabetes and diabetes. This study identified individuals at risk for prediabetes and a need for more education about modifiable risk factors for prediabetes. Identification of a population at risk is an important step in strengthening lines of defense and preventing penetration of the client system. Stronger lines of defense will prevent or delay the development of prediabetes and further progression to T2DM.

Limitations

The purpose of this thesis was to identify adults at risk for prediabetes, in a rural community setting, and explore the relationship between adults' perceived risk for prediabetes and actual measured risk for prediabetes as determined by the CDC Prediabetes Screening Test. A possible limitation to this study included the small sample size. The data was collected via a convenience sampling method at a church in western North Carolina. The study could have been more robust with a larger sample size. A larger sample size with diverse demographics could provide different results about the relationship of self-appraised risk and actual measured risk of prediabetes.

Implications for Nursing

One-third of adults in the United States have prediabetes (CDC, 2017a). Of those with prediabetes, up to 70% will develop T2DM (Tabak et al., 2012). Diabetes is the costliest chronic illness to the United States economy (Dieleman et al., 2016), and was seventh leading cause of death in 2014 (Heron, 2013). The ADA reports that individuals with diagnosed diabetes incur about $13,700 in medical expenditures each year. Approximately 60% of that cost is directly associated with diabetes. Additionally, diabetes can result in reduced productivity such as increased absenteeism, inability to work due to disability, and lost productive capacity due to early mortality (ADA, 2015).

In 2011, a diabetes belt was identified in the United States. This belt consists of 644 counties in 15 mostly southern states (Barker et al., 2011). Within the diabetes belt, 11.7% of individuals have diagnosed diabetes, compared with a national average of 8.5% (Barker et al., 2011). More recent data reveals the national average of diabetes is now 9.3% (CDC, 2014).

North Carolina is one of the states identified in the 2011 diabetes belt (Barker et al., 2011). Ninety-three of North Carolina's 100 counties have a higher prevalence of diabetes than the national average, with Cleveland County ranking 51 out of 100 in diabetes prevalence in the state. Individuals with diagnosed diabetes in Cleveland County is 12.4% (CDC, 2013), 25% higher than the national average.

This study found that many individuals are unaware of the risk factors for prediabetes. Many individuals are also unaware of the significance of modifiable risk factors in the prevention of prediabetes (Akter et al., 2014). Lifestyle modifications, such as weight loss and exercise, can potentially reverse or prevent prediabetes and could delay the progression to T2DM (ADA, 2016a). Use of a prediabetes screening tool, such as the CDC Prediabetes Screening Test, is helpful in identifying individuals at high risk for prediabetes, and can also help individuals identify which lifestyle modifications can be effective in reducing their risk for prediabetes (Poltavskiy et al., 2016). Individuals at risk for prediabetes need to be identified so that appropriate education and lifestyle modifications can be addressed.

It is important for nurses, and other healthcare professionals, to realize the need of education about prediabetes in the public. Many individuals may make lifestyle modifications if they were made aware of their risk for prediabetes and the risk prediabetes predisposes upon other morbidities, such as T2DM, coronary heart disease, and chronic kidney disease.

Healthcare in the United States is becoming more focused on prevention. Community education can provide a foundation for individuals to obtain a general

knowledge of disease processes. That knowledge will equip those individuals to make better choices in preventing development, or progression, of disease.

Patient education and health literacy are essential for health and prevention (CDC, 2015), and inefficient health literacy has been associated with poorer health status (Lee et al., 2015). Educating individuals about risk factors for prediabetes and identifying those at risk, can help improve the health of populations and reduce cost of healthcare. Knowledge of the prevalence and associated risk factors of prediabetes can raise awareness of the disease and lead to strategies for prevention and management (Akter et al., 2014).

Recommendations

Prediabetes is a disease that often goes unnoticed until a person's normal line of defense is compromised. For this reason, it is important to address prediabetes at the community level. Education about risk factors and lifestyle choices that can influence risk factors, can empower individuals make choices that can help delay or prevent prediabetes (Li et al., 2008).

Identification of at-risk populations is an important step in reversing prediabetes and preventing the progression to diabetes. Educating populations most at risk, such as those in the diabetes belt, can help in reversing the trend in diabetes prevalence and decreasing the size of the diabetes belt in the United States. Decreasing the prevalence of prediabetes and diabetes will improve the health of populations and reduce the per capita cost of healthcare.

Conclusion

Exploring the relationship of adults' self-appraisal of prediabetes risk and actual measured risk for prediabetes as determined by the CDC Prediabetes Screening Test was the aim of this study. The results revealed a significant difference between self-appraised risk and measured risk for prediabetes. There was also a significant difference found between self-appraised risk and measured risk for prediabetes in a subgroup of individuals with high measured risk for prediabetes.

This study was done in North Carolina, a state in the diabetes belt, which has a higher-than-average prevalence of diabetes in the United States. The fact that 55.6% of participants in this study, who had a high measured risk of prediabetes, measured their risk as low reveals the urgent importance of prediabetes education in this population. This study revealed that individuals are generally not aware of the risk factors for prediabetes. Individuals at risk for prediabetes need to be identified so that appropriate education and lifestyle modifications can be addressed. Community education about disease processes and prevention of those processes is essential in improving the health of populations and reducing the per capita cost of healthcare.

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Appendix A

External Permission Statement

Amanda Sowell is a registered nurse studying perceived risk for prediabetes vs. actual prediabetes risk as determined by the CDC Prediabetes Screening Test. This study will provide information regarding the need for prediabetes risk education in the general public.

The purpose of the research is to identify adults at risk for prediabetes and explore the relationship between adults' perceived risk for prediabetes and actual measured risk for prediabetes as determined by the Centers for Disease Control and Prevention (CDC) Prediabetes Screening Test. This study and its procedures are pending approval by the Institutional Review Board of Gardner-Webb University's Hunt School of Nursing. The study procedures may identify participants as having a low or high risk for prediabetes.

The procedures include: identifying one's own risk for prediabetes; completing basic demographic information; and participating in the CDC Prediabetes Screening Test, which consists of seven questions regarding risk factors for prediabetes.

The study will take place on a Sunday morning in June, 2017, during adult Sunday School classes. Participation in this study will take approximately ten minutes. Participants will be free to ask any questions during or after the study and can contact the researcher, Amanda Sowell, at any time at 704-472-7141. Participation in this study is voluntary. Those participating are under no obligation to participate and have the right to withdraw at any time.

The study data will be coded so they will not be linked to the participant's

name. The participant's identity will not be revealed while the study is being conducted or when the study is reported or published. All study data will be collected by Mrs. Sowell, stored in a secure place, and not shared with any other person without their permission.

Participation in this study will not lessen or increase risk for prediabetes.

Participation in this study will provide participants with information about their own risk for prediabetes and how they can possibly decrease their risk for developing prediabetes or diabetes. Those participants identified as having a high risk for prediabetes will be asked to follow up with their primary care physician.

I give Amanda Sowell permission to conduct the above study at Double Springs Baptist Church during the Sunday School hour. All participation will be voluntary.

Rev. Bill Jones — 4/11/17

Pastor \

Danny Kruger — 4/12/2017

Chairman of Deacons

Date

Appendix B

Informed Consent

Researcher: Amanda Sowell, RN, BSN

Introduction and Purpose: You are being asked to be in a research study that will provide information about the need for prediabetes risk education in the general public. Prediabetes is a disease where blood sugar levels are higher than normal, but not yet high enough to be diagnosed as diabetes. This study and its procedures have been approved by the Pastor and Chairman of Deacons at this church, and by the Gardner-Webb University Hunt School of Nursing Institutional Review Board. Please read this form and ask any questions that you may have before agreeing to be in this study.

Description of the Study Procedures: If you agree to be in this study, you will be asked to answer two surveys. In the first survey, you will be asked to rate your perceived risk for developing prediabetes as "low" or "high". The second survey is a prediabetes screening tool provided by the Centers for Disease Control and Prevention, and contains 7 questions that will determine your actual risk for developing prediabetes. Participation in this study will take approximately 10 minutes.

Risks of Being in this Study: Potential risks for participating in this study are minimal, but include awareness of potential risk for prediabetes. All participants will be provided with information about prediabetes after participation.

Benefits of Being in this Study: Participation in this study will not lessen or increase your risk for prediabetes. Participation in this study will provide you with information about prediabetes.

Confidentiality: The study data will be coded so they will not be linked to your name. Your identity will not be revealed while the study is being conducted or when the study is reported or published. All study data will be collected by the researcher and secured in a locked file inside of a locked room, to which only the researcher has a key. No data will be shared with any other person without your permission.

Right to Refuse or Withdraw: Participation in this study is voluntary. You are under no obligation to participate. You have the right to withdraw at any time during the study.

Right to Ask Questions and Report Concerns: You have the right to ask questions about this research study and to have those questions answered by the researcher at any time during or after the study. If you have any further questions about the study, feel free to contact me, Amanda Sowell at 704-472-7141.

Consent: Your signature below indicates that you have decided to volunteer as a research participant for this study, and that you have read and understood the information provided above. You will be provided a copy of this form to keep.

_____ _____

Participant's signature Date

Appendix C

Prediabetes Self-Appraisal

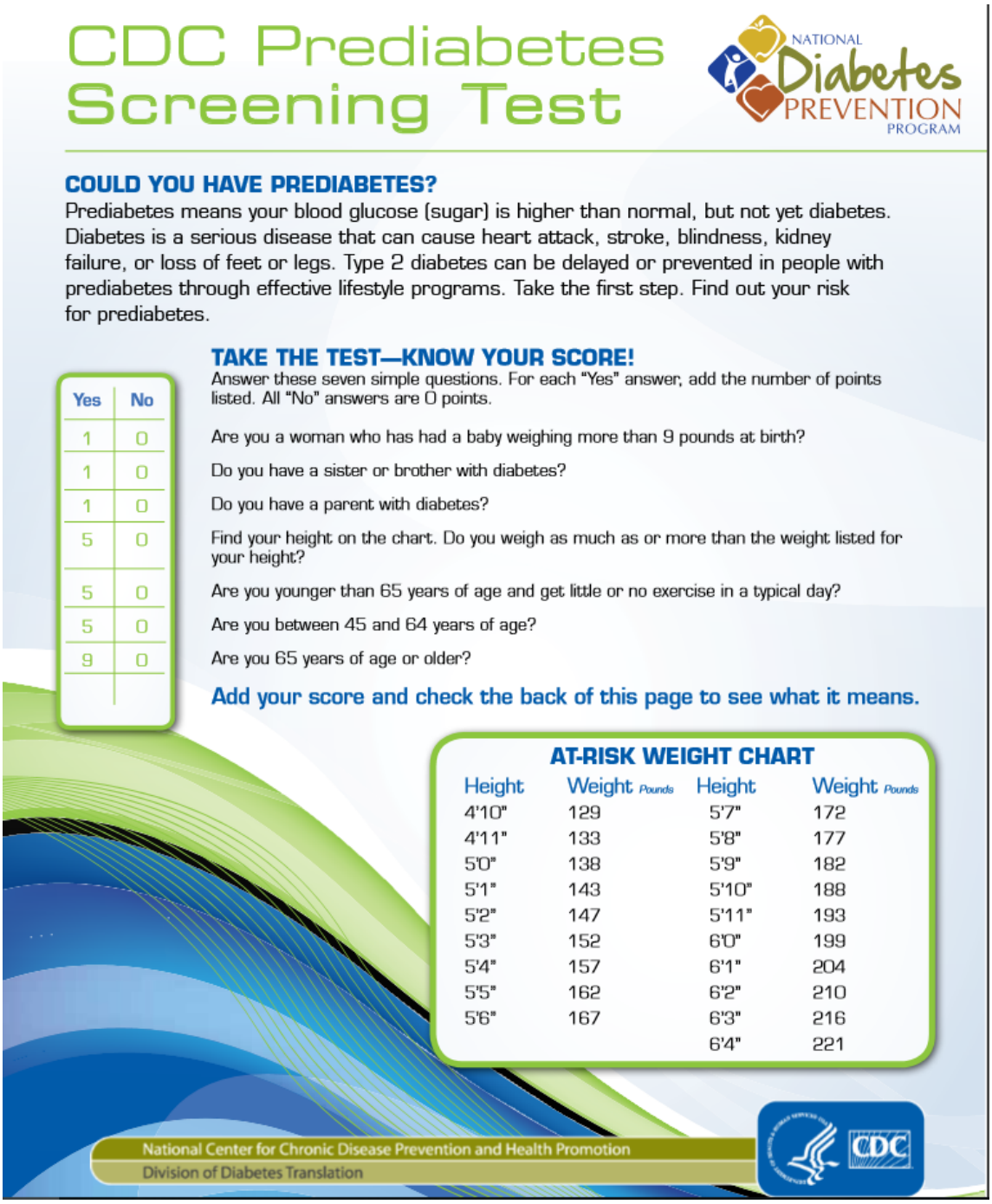
How would you rate your current risk for prediabetes (select one)?

☐ Low

☐ High

Appendix D

CDC Prediabetes Screening Test



CDC Prediabetes Screening Test

NATIONAL Diabetes PREVENTION PROGRAM

COULD YOU HAVE PREDIABETES?

Prediabetes means your blood glucose (sugar) is higher than normal, but not yet diabetes. Diabetes is a serious disease that can cause heart attack, stroke, blindness, kidney failure, or loss of feet or legs. Type 2 diabetes can be delayed or prevented in people with prediabetes through effective lifestyle programs. Take the first step. Find out your risk for prediabetes.

TAKE THE TEST—KNOW YOUR SCORE!

Answer these seven simple questions. For each "Yes" answer, add the number of points listed. All "No" answers are 0 points.

Yes	No	
1	0	Are you a woman who has had a baby weighing more than 9 pounds at birth?
1	0	Do you have a sister or brother with diabetes?
1	0	Do you have a parent with diabetes?
5	0	Find your height on the chart. Do you weigh as much as or more than the weight listed for your height?
5	0	Are you younger than 65 years of age and get little or no exercise in a typical day?
5	0	Are you between 45 and 64 years of age?
9	0	Are you 65 years of age or older?

Add your score and check the back of this page to see what it means.

AT-RISK WEIGHT CHART

Height	Weight *Pounds*	Height	Weight *Pounds*
4'10"	129	5'7"	172
4'11"	133	5'8"	177
5'0"	138	5'9"	182
5'1"	143	5'10"	188
5'2"	147	5'11"	193
5'3"	152	6'0"	199
5'4"	157	6'1"	204
5'5"	162	6'2"	210
5'6"	167	6'3"	216
		6'4"	221

National Center for Chronic Disease Prevention and Health Promotion
Division of Diabetes Translation

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IF YOUR SCORE IS 3 TO 8 POINTS

This means your risk is probably low for having prediabetes now. Keep your risk low. If you're overweight, lose weight. Be active most days, and don't use tobacco. Eat low-fat meals with fruits, vegetables, and whole-grain foods. If you have high cholesterol or high blood pressure, talk to your health care provider about your risk for type 2 diabetes.

IF YOUR SCORE IS 9 OR MORE POINTS

This means your risk is high for having prediabetes now. Please make an appointment with your health care provider soon.

HOW CAN I GET TESTED FOR PREDIABETES?

Individual or group health insurance: See your health care provider. If you don't have a provider, ask your insurance company about providers who take your insurance. Deductibles and copays may apply.

Medicaid: See your health care provider. If you don't have a provider, contact a state Medicaid office or contact your local health department.

Medicare: See your health care provider. Medicare will pay the cost of testing if the provider has a reason for testing. If you don't have a provider, contact your local health department.

No insurance: Contact your local health department for more information about where you could be tested or call your local health clinic.

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www.cdc.gov/diabetes

Appendix E

Prediabetes Education

REFERENCES

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Knowler WC, Barrett-Conner E, Fowler SE, et al; Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med 2002;346:393–403. As cited in March 22, 2013, MMWR.

Tuomilehto J, Lindstom J, Eriksson J, et al; Finnish Diabetes Prevention Study Group. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. N Engl J Med 2001; 344:1343–1350.

CDC's Division of Diabetes Translation works toward a world free of the devastation of diabetes.