1-1-2021

Diabetes Management and Self-Perception of Health Among Adults in the United States

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This is to certify that the doctoral dissertation by

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the review committee have been made.

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Walden University

2021

Abstract

Diabetes Management and Self-Perception of Health Among Adults in the United States

by

Moses Ajoku

MPH, Benedictine University, 2010

BS, Old Dominion University, 2005

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health – Epidemiology

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Abstract

The burden and complications of diabetes have been a public health concern and societal challenge for decades, and the rate of prevalence is projected to increase in the future. The study aims to examine the association between blood glucose monitoring, glycated hemoglobin test, and self-perceived health status among diabetic adults in the United States. Guided by the chronic care model, the study used data from the 2019 Behavioral Risk Factor Surveillance System to investigate diabetes management practices among diabetic adults in the United States. Quantitative and cross-sectional methods were used to assess the associations between diabetes management practices and self-perceived health status. Ordinal logistic regressions showed that the odds ratio of regular blood glucose monitoring [Exp (B) = 1.251, $p < 0.05$, 95% CI (1.160, 1.350)] and glycated hemoglobin tests (two times or more) [Exp (B) = .735, $p < 0.05$, 95% CI (.615, .878)] have statistically significant relationships with self-perceived health status. The moderation analysis showed a statistically significant association and direct interaction effect between race/ethnicity and blood glucose monitoring [B = .0076, $p < 0.05$, 95% CI (-.0009, .0144)]. The implications of social change from these results include a better understanding of how diabetes management practices impact self-perceived health status in reducing the prevalence and complications of the disease. Based on the results, people with diabetes who do not practice regular glucose monitoring can be targeted by health care professionals for effective diabetes management plans. Further studies are needed to evaluate the impact of glycated hemoglobin tests on the self-perception of health status among individuals with diabetes.

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Dedication

This dissertation is dedicated to the cherished memory of my mother, Ms. Patricia Ajoku, who passed away in 2008 after a brave battle with diabetes. I also would like to dedicate this study to my loving family for their unwavering support and heroic patience during the long time of my doctoral studies. I treasure the pleasant distractions from my younger daughters during the extended hours of doctoral study. I will now devote my life to loving and enjoying every moment with family.

Acknowledgements

I express my gratitude to my doctoral committee chair, Dr. Srikanta Banerjee, for his guidance and encouragement. Thank you for the motivation, persistence, and for believing in me. Dr. Robin Carlson made immense contributions to the success of my doctoral study and was relentless in her focused feedback and diligence. Indeed, I would not be telling a success story about my doctoral study without her holding me to the highest standards of academic excellence. I want to convey a debt of gratitude to Dr. Aimee Ferraro for her considerable prowess in guiding my final dissertation paper. I also want to acknowledge Dr. Pricilla Belin, my first committee chair, and Dr. W Sumner Davis, my University Research Reviewer, for their expertise and guidance.

I want to acknowledge and thank my good friends, Dr. Christopher Azode and Mr. Chukwuma Ukwuoma, for encouraging me to persevere and never give up. Of course, another appreciation for my family and friends for their resilience and determination to see me through the finish line for my doctoral program.

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Chapter 1: Introduction to the Study

Diabetes has been a public health concern for decades, and the prevalence rate is projected to increase in the future. An estimated 422 million people worldwide have diabetes (World Health Organization [WHO], 2014). The number of individuals with diabetes in the United States was 34.2 million in 2018, and it is projected to double by 2050 as 1.5 million cases are diagnosed annually (American Diabetes Association [ADA], 2018; CDC, 2017). Though diabetes was the seventh leading cause of death in the United States in 2018, it is underreported as the underlying cause of death (ADA, 2018).

The diagnosis of diabetes can convey a poor perception of health among individuals with chronic diseases, just as self-perceived health (SPH) status can influence health service utilization, coping mechanisms, mortality, and morbidity rates. It is, therefore, essential to understanding an individual's SPH status relating to diabetes, which is not only a valuable tool in achieving and maintaining glycemic control, but also enables health care providers to design intervention programs to improve outcomes (Kowall et al., 2017). Reducing the complications of diabetes and improving the health-related quality of life with the disease is a public health goal. A continued intervention to promote healthy behaviors and improve the management of diabetes would not only prevent diabetes complications but also enhance SPH status, which allows for effective prevention, management, and treatment plans to improve the health, quality of life, and awareness of diabetes-related complications (CDC, 2021). My study adds to the existing findings regarding the correlation of glycated glucose and glucose monitoring with self-reported health status, underscoring the poor SPH status among individuals with diabetes.

In this chapter, I discuss the synopsis of this study. The Background section consists of information related to the prevalence of diabetes and the associated complications, showing the gap in the literature and the justification for this research. The problem statement shows the significance of this research on the prevalence of diabetes in the United States. I also discuss the purpose of the study and how I conducted the research. The research questions and hypotheses are also stated as well as the theoretical foundation that guides the study. The chapter also consists of the key definitions, assumptions, scope and delimitations, limitations, and a summary.

Background of the Study

The two common types of diabetes are type 1 and type 2 diabetes. Type 1 diabetes (5–10% of all diabetes cases) involves the pancreas cells' inability to secret enough insulin due to autoimmune disease, and type 2 diabetes (90 to 95% of all diabetes cases) is the combination of insulin resistance and inadequate production in the body. Type 2 diabetes is the most common of all diabetic cases and is associated with obesity, inactivity, or genetic predispositions (DiClimente et al., 2013). Diabetes in older adults is an increasing public health issue in the United States as the group has the highest prevalence and risks for the complications of diabetes due to a glucose tolerance from increased sedentary lifestyles (Kirkman et al., 2012).

Diabetes of all types can result in severe complications and increase the overall risk of mortality and morbidity (Arizona Department of Health Services and Bureau of

Tobacco and Chronic Disease, 2015). The complications associated with diabetes include, but are not limited to, kidney failure, retinopathy, neuropathy, and amputations (Reyes, 2017). The recommended components of diabetes management include optimizing glycemic control and diabetes care through blood glucose monitoring (BGM), glycated hemoglobin (HbA1c) tests, feet, eye exams, physical activities, and nutrition plans.

Though some individuals from every race and ethnic group in the United States have diabetes (HealthyPeople2020, 2018), the health and economic burden of diabetes is not evenly shared across all racial and ethnic diabetes populations. Studies have consistently shown that in terms of the prevalence and complications of diabetes, the disproportionate burden of diabetes is evident among minority communities, including African Americans, Hispanics, and Native American Indians. National survey data from 2010 showed that 7.6% of non-Hispanic White adults, 12.9% of African American adults, 13.2% Hispanic adults, and 16.5% of Native American Indian adults had been diagnosed with diabetes (Chen et al., 2014). Furthermore, mortality and morbidity rates due to diabetes complications are higher among minority populations than Whites in urban and rural settings (Glenn et al., 2020). The inequitable distribution of health resources and socioeconomic factors contribute to the challenges between diabetes self-management and treatment plans, resulting in the prevalence and complications of diabetes (Kleirer & Dittman, 2014).

In addition to addressing health inequity, research suggests that diabetes self-management is the cornerstone of diabetes care, and SPH status is essential in deciding whether individuals with diabetes follow recommended treatment and management plans (Kugbey et al., 2017). Some studies found SPH status as a significant factor that influences self-care practices and health outcomes among people living with diabetes and other chronic diseases. Diabetes management practices and SPH status involve a decision-making process that depends on patients' understanding of their health conditions, whether it is manageable, curable, or severe. SPH among individuals with diabetes also influences compliance with recommended treatment goals, including glucose monitoring, adherence to medication, diet, and physical activities (Kugbey et al., 2017). More efforts and resources should be directed toward understanding the struggles with diabetes self-management and care utilization among underserved communities (Reyes et al., 2017). Without implementing effective diabetes management practices and understanding the impact on perceived health status, individuals with the disease may face significant challenges and increasing burdens.

Though there are several studies on the prevalence of diabetes and diabetes management, few have explored the association between BGM, HbA1c test, and SPH status among adults diagnosed with diabetes in the United States. This gap in the literature may affect the diabetes prevalence rate among adults in the United States. The prevalence and impact of diabetes have continued to increase, underscoring the significance of optimizing diabetes management among adults to reduce disease burden and improve health status and quality of life. Contributing factors to diabetes management's poor compliance should be considered in intervention programs to reduce diabetic complications (Tull & Roseman, 2018). Therefore, this study addressed the association between BGM, HbA1c test, and SPH status among adults diagnosed with diabetes in the United States. I also evaluated the interaction effect of race and ethnicity on the relationship between BGM and SPH status.

Problem Statement

Diabetes management activities such as BGM, HbA1c test, diet, exercise, and medications are beneficial; however, the association between BGM, HbA1c test, and SPH status among adults diagnosed with diabetes in the United States is unknown. Earlier studies have also not addressed the impact of race on the association between BGM and SPH status. If these potential gaps in diabetes management are not evaluated, they may lead to missed opportunities to reduce the risk factors and disease mortality. Given the increasing burden of diabetes on the health of people with the disease, it is critical for medical and public health care organizations to mitigate diabetes prevalence by promoting quality diabetes care and management. Though several recent studies suggest the need to focus on recommended guidelines for chronic disease management, few explored the impact of BGM on SPH status or the effect of the HbA1c tests on SPH status and whether race modifies the association between BGM on SPH status among diabetes adult populations. In this study, I addressed this gap in research, as findings ways to improve BGM and HbA1c test outcomes are critical to achieving optimal glycemic control and reducing the associated mortality, morbidity, and economic burden of the disease.

Purpose of the Study

Because of the increasing prevalence of diabetes and the risk factors associated with the disease, I conducted quantitative and cross-sectional research using secondary data to evaluate whether BGM and HbA1c tests are associated with SPH status. Quantitative research enabled the understanding of the association between BGM and HbA1c test and SPH status, which may facilitate the design of health care systems and professions to prevent the disease, improve health outcomes, and promote quality of life. Using data from the 2019 National Behavioral Risk Factor Surveillance System (BRFSS) surveys and statistical analyses, I explored the associations between the independent and dependent variables for this study. I also examined the modifying effect of race/ethnicity on the association between BGM and SPH status. The variables were selected because they reflect diabetes self-management activity and clinical care for individuals with diabetes. The results of my study may also influence the re-design and development of intervention strategies to meet the needs and circumstances of individuals with diabetes, improve the quality of life, and reduce costly complications associated with the disease.

Research Questions and Hypotheses

The study used three research questions and hypotheses to examine the association between BGM, HbA1c test, and SPH status among adults with diabetes in the United States:

Research Question 1: In the context of diabetes management, how is BGM associated with SPH status among adults in the United States while controlling for age, gender, race/ethnicity, education, and poverty level?

$H_0$1: In the context of diabetes management, BGM is not associated with SPH status among adults in the United States after controlling for age, gender, race/ethnicity, education, and poverty level.

$H_1$1: In the context of diabetes management, BGM is associated with SPH status among adults in the United States after controlling for age, gender, race/ethnicity, education, and poverty level.

Research Question 2: In the context of diabetes management, how is the HbA1c test associated with SPH status among adults in the United States while controlling for age, race/ethnicity, gender, education, and poverty level?

$H_0$2: In the context of diabetes management, HbA1c tests are not associated with SPH status among adults in the United States after controlling for age, gender, race/ethnicity, education, and poverty level.

$H_1$2: In the context of diabetes management, HbA1c tests are associated with SPH status among adults in the United States after controlling for age, gender, race/ethnicity, education, and poverty level.

Research Question 3: Does race modify the association between BGM and SPH status after controlling for age, gender, education, and poverty level?

$H_0$3: Race/ethnicity will not modify the association between BGM and SPH status among adults in the United States after controlling for age, gender, education, and poverty level.

$H_1$3: Race/ethnicity will modify the association between BGM and SPH status among adults in the United States after controlling for age, gender, education, and poverty level.

Theoretical Foundation

The chronic care model (CCM) framework was used to evaluate the association between BGM, HbA1c tests, and SPH status among adults diagnosed with diabetes in the United States and the modifying effect of race on the association between BGM and SPH status. I used the framework to examine how intervention programs using the CCM constructs and recommended guidelines for chronic disease care may improve diabetes management.

Wagner developed the CCM in 1998 based on the meta-analyses of successful practices and system changes leading to improved chronic illness care (Si et al., 2008). The model was also derived from reviews and synthesis of interventions in various settings across multiple chronic disease conditions and healthcare systems (Bustamente et al., 2018). The CCM describes the interactions between health care system functions in guiding chronic disease management. The components of CCM include self-management support, healthcare systems, delivery system design, decision, and clinical information systems (Si et al., 2008).

Since the development of CCM, it has been widely used in health care settings to improve chronic disease care, including diabetes management (Si et al., 2008). Recent health care studies have also used CCM to show evidence-based and practical strategies to prevent diabetes and improve outcomes. The model provides patients with self-management skills, tracking systems in self-care, and utilizing clinical services for diabetes management (Stellefson et al., 2013). The CCM has also allowed for more collaborative, patient-oriented approaches to the health care delivery system by emphasizing active participation and informed health care utilization to promote diabetes self-management (Glenn et al., 2020). Evidence shows that functional and clinical supports have positively influenced diabetes management care, resulting in glycemic control. In this study, I focused on two constructs—self-management support and the health care systems care to evaluate the association between BGM, HbA1c tests, and SPH status.

Self-Management Supports

As provided in the model, the "self-management support" construct emphasizes the importance of a patient's engagement in managing their care. The construct refers to the coping mechanisms and knowledge, and skills to improve health and wellness. As individuals with diabetes are expected to practice self-care and regularly monitor their blood glucose levels, the self-management support construct was used to evaluate the impact of BGM on SPH status among adults living with diabetes. Diabetes self-management support provides advice with medication compliance, foot care examination, and physical activity to achieve diabetes self-management goals (Stellefson et al., 2013). CCM constructs imply that effective self-management will facilitate how individuals cope with the challenges and manage diabetes to reduce the emotional and psychological impact of the disease (Bustamente et al., 2018). Effective diabetes self-management requires that individuals engage in activities that promote and improve health, such as provider-to-patient interactions and adequate engagement in self-management behaviors.

Health care Systems

The “health care systems” construct refers to program planning that involves measurable goals for better care and outcome of chronic diseases (Stellefson et al., 2013). The concept refers to the leadership roles in approving resources and eliminating healthcare barriers in diabetes management. The construct also includes establishing diabetes management training programs to help identify individuals at risk of developing complications and improving clinical and behavioral outcomes. Several studies have documented positive clinical outcomes as indicators of CCM’s effectiveness in diabetes management, both in clinical settings and personal environments. This study used the construct to evaluate the impact of HbA1c testing on SPH status among adults living with diabetes.

Rationale

I selected the CCM to guide my study approach in evaluating the research questions and variables: BGM and HbA1c test related to SPH status. The primary goals of diabetes management are to ensure glycemic control, improve health status and quality of life related to the CCM elements. A slight to moderate improvement in health outcomes has been associated with diabetes management following CCM components’ implementation (Davy et al., 2015). The CCM elements focus on enabling self-management support (BGM), improving health care practices (HbA1c test), and promoting general SPH status (Davy et al., 2015), which may help improve diabetes management among adults in the United States.

Nature of the Study

I used a quantitative, cross-sectional design to evaluate the association between BGM, HbA1c test, and SPH status. I utilized the 2019 National BRFSS datasets from the Centers for Disease Control and Prevention (CDC). The independent variables have ordinal levels of measurement, whereas the dependent variable has an ordinal measurement. I employed ordinal logistic regression to determine whether there is an association between BGM and SPH status in addition to an association between the HbA1c test and SPH status. Finally, moderation analysis was used to determine if race modifies the association between BGM and SPH status. The result was considered significant if the p-value was < 0.05. The G*P software version 3.1.9.4 was used to calculate the sample size for each research question (see Appendix B). The logistic regression analyses, moderation analysis, and descriptive statistics were computed using the Statistical Package for the Social Science (SPSS) version 27.

Definitions

Blood glucose monitoring (BGM): This refers to blood glucose testing to determine blood glucose levels. The criteria for the diagnosis of diabetes, according to the ADA, are two fasting blood glucose levels equal to or greater than 126 mg/dl on two separate occasions or a random blood glucose level equal to or greater than 200 mg/dl with symptoms (ADA, 2015). BGM is an independent variable that was evaluated with self-reported responses in the BRFSS dataset.

Diabetes incidence: This is the number of new cases of diabetes occurring within a period (National Center for Health Statistics, 2018).

Diabetes management: This refers to diabetes self-management activities and clinical care from health care professionals to prevent and manage diabetes to improve the risk factors and adequacy of care (Lutfiyya et al., 2011).

Diabetes prevalence: This is the actual number of individuals living with diabetes during a period or point in time or the frequency of diabetes cases within a defined community at a point in time (National Center for Health Statistics, 2018).

Diabetes self-management: This is the ability of an individual to achieve glycemic control due to modified behaviors, including blood glucose testing, physical activities, healthy diet, periodic foot, eye exams, and medication adherence (Weller et al., 2017).

Diabetes self-management education: This is the process of conveying and utilizing the knowledge and understanding of skills needed to advance the management of diabetes (Boakye et al., 2018).

Dietary management: This is the regular consumption of healthy food items in line with treatment goals. The ADA recommends dietary management to improve and maintain glycemic targets and treatment goals (ADA, 2018).

Eye examination: This refers to the annual eye dilation examination performed by health care professionals for retinopathy screening. The American Association of Diabetes Educators and the ADA recommend annual dilated eye examinations for individuals diagnosed with diabetes to prevent visual impairment and blindness (ADA, 2018).

Foot care: This refers to the regular foot examination to reduce the chances of injury or damage that may result in serious complications. The American Association of Diabetes Educators and the ADA suggest regular home foot care and periodic foot examinations for individuals diagnosed with diabetes (ADA, 2015).

Glycated hemoglobin (HbA1c) test: This refers to increased HbA1c testing by health care professionals to determine the average blood glucose level in 3 or 6 months to assess compliance with treatment goals. The HbA1c test is an independent variable that was evaluated with self-reported responses in the BRFSS dataset.

Medication adherence: This is the collaborative engagement of a patient in a shared acceptable course of behavior to produce a therapeutic outcome (Senteio & Veinot, 2014).

Physical activity/exercise: This is the amount of time a diabetes individual engages in physical activities or recreations other than routine duties. Physical exercise means engaging in moderate to vigorous physical activity for 30 or more minutes per day for 3–5 days a week. The ADA recommends regular exercise and losing weight to balance with treatment goals (ADA, 2015).

Race: This is a group of people classified by common racial, tribal, national, or sociocultural identifications, including American Indians/Alaskan Natives, Asians, Blacks / African Americans, Native Hawaiians, or Other Pacific Islanders or Whites (National Institutes of Health, 2021).

Self-perceived health (SPH) status: This is the general perception of health, which reflects on the general health, glycemic control, and well-being of respondents by meeting diabetes screening guidelines, reaching diabetes diagnostic and treatment goals for optimal diabetes care (Lorem et al., 2020). SPH status is the dependent variable and was evaluated by selecting the questions and responses.

Assumptions

There are three assumptions associated with my study:

1. I assumed that respondents had provided accurate survey questions since this is a secondary data analysis that contained self-reported responses. To ensure that participants provided accurate information in the BRFSS survey, they were assured that personal data would be de-identified and kept confidential.
2. I assumed that the sample accurately represented the population from which it was drawn. The BRFSS is a telephone survey of adults in geographical stratifications and varying demographics. BRFSS uses data weighting methodology to allow additional design and demographic characteristics to make sample data representative of the population.
3. I assumed that respondents were eligible households/persons as determined in the BRFSS survey eligibility requirement.

The eligibility factor is essential in calculating of response, refusal, or non-response rates (CDC, 2021). Design weights account for the probability of selection and adjustment of non-response bias and non-coverage errors. BRFSS also uses iterative proportional fitting (IPF) to adjust for demographic differences among individuals sampled and the population they represent (CDC, 2020). IPF incorporates cellular survey data and allows for more demographic characteristics that reflect populations' sample distribution at state and local levels.

Scope and Delimitations

First, the scope of this study was limited to evaluating diabetes as one common diagnosis without differentiating several types of diabetes. As a secondary dataset, the 2019 BRFSS data consist of a sample of individuals with known diabetes diagnoses without distinguishing type 1 or type 2 diabetes. Since most diabetes cases are type 2 diabetes, additional research may be needed to examine the relationship between several types of diabetes and SPH status.

Second, the scope of study was limited to adults 18 years and older who diagnosed diabetes as reported in the BRFSS dataset. In addition, the sample population also consisted of male and female respondents, but there was no differentiation based on sex or gender in the study analyses.

Finally, the scope of this study was limited to the evaluation of two diabetes management practices: BGM and HbA1c tests for diabetes management. Other recommended diabetes management activities not evaluated in this study include physical activity, nutritional plan, medication adherence, foot care, and eye exams. I only focused on BGM and HbA1c test and how they relate to SPH status among adults with diabetes in the United States.

Limitations

The following limitations may be considered in the findings of this study. First, the study is a secondary data analysis, which was based on telephone surveys of households. Telephone surveys have the potential for non-coverage errors due to the inability to reach some households and individuals, and therefore may not truly represent the population. A systemic failure may also exist in the BRFSS survey due to limited telephone coverage among young, transient, and low socioeconomic status populations, resulting in non-coverage, non-response, or measure (Arizona Department of Health Services and Bureau of Tobacco and Chronic Disease, 2017).

Second, BRFSS data are based on self-reported responses. Self-reported data are subjective and depend on the respondent's perspective, which may differ from objective health status assessments, resulting in a bias (CDC, 2020). As a result of the reported responses, the study result may not be suitable for generalization to a larger population. However, BRFSS uses design weights to adjust for age, race, sex, and other demographic variables to reduce non-coverage and non-response biases and errors at state levels. The IPF or (raking) is also used to adjust for demographic differences among individuals sampled and the population they represent. IPF incorporates cellular survey data and allows for more demographic characteristics that reflect the population's sample distribution at the state and local levels (CDC, 2020). Third, since the study is a cross-sectional research approach, it is not suitable for generalization to the larger population.

Despite the limitations, BRFSS data are dependable, valid, and correspond with data based on face-to-face interviews such as National Health Interview Survey and the National Health and Nutrition Examination Survey (CDC, 2020). BRFSS survey data also enable the identification of associations due to the large sample size and representation.

Significance of the Study

The findings of this study may lead to the review and re-designing of the roles of health care systems, health care professionals, and patients in the diabetes continuum of care. The health care systems may need to implement intervention strategies at all levels in the diabetes management process by applying the CCM. Furthermore, intervention strategies for diabetes management practices may advance the CCM's objectives of bridging the knowledge gap (Kadu & Stolee, 2015) and directing health care systems modifications to achieve sustained improvement and outcomes in diabetes care (Stellefson et al., 2013).

Social Change

The association between BGM, HbA1c tests, and SPH status is unknown among adults diagnosed with the disease in the United States. This study adds to the body of knowledge by evaluating this association. Successful diabetes management, including BGM and HbA1c tests, can improve glycemic control, health status, and quality of life through modified behaviors. Diabetes self-management leads to managing the disease daily, access to health care, and provider interactions. Thus, ineffective glycemic control may be associated with behavioral risks, including irregular BGM and insufficient HbA1c test, sedentary lifestyles, unhealthy diet, and disparities to access to healthcare. These behavioral risk and socioeconomic factors can exacerbate diabetes complications, increase individuals' burden, and negatively affect self-perception of health status.

Adequate understanding of diabetes management practices and resources will help develop effective strategies to improve BGM and HbA1c tests to enhance the quality of life and achieve optimal health status. Diabetes management, whether it is self-care or clinical care, is essential to achieve and maintain optimal glycemic control and improve health and quality of life. Positive social change can be achieved by improving BGM and HbA1c tests and SPH status. The improvement could reduce mortality rates, the severity of disease complications, and economic burden regardless of gender, race/ethnicity, education, or poverty level.

Summary and Transition

Though diabetes is a common disease in the United States (HealthyPeople2020, 2018), few studies have focused on the association between BGM and HbA1c tests and SPH status among adults diagnosed with the disease in the United States. In this research, I used a quantitative and cross-sectional method to explore the association between BGM and HbA1c tests and SPH status by evaluating the selected variables in the BRFSS datasets. I utilized the CCM to understand the environment and social circumstances necessary to implement diabetes management programs. In Chapter 2, I will discuss the literature relevant to the study topic. Chapter 3 will discuss the research methods, including the population of interest, sampling procedure, data collection method, operationalization of constructs, instruments, and data analyses.

Chapter 2: Literature Review

Diabetes is a chronic disease with debilitating complications and a significant economic burden. The number of individuals with diabetes in the United States was 34.2 million in 2018 and is projected to double or triple by 2050 (ADA, 2018). Diabetes management, including BGM, HbA1c tests, diet, exercise, foot care, eye exams, and medications, are reported as fundamental elements and recommended components of diabetes care. However, it is unknown how BGM and HbA1c tests are associated with SPH status among adults in the United States. The lack of research on the association between BGM and HbA1c tests and SPH status are potential gaps evaluated in this study. Additionally, I explored the impact of race on the association between BGM and SPH status. The purpose of my study was to evaluate whether BGM and HbA1c tests are associated with SPH status among adults diagnosed with diabetes in the United States and whether race modifies the association between blood glucose health and SPH status.

Literature Search Strategy

I explored online literature databases in the health sciences and multidisciplinary fields to search and locate relevant literature. The search for past literature includes, but is not limited to, ProQuest Central, EBSCOhost, Dissertations and Theses at Walden University, CINAHL Plus with Full Text, Academic Search Complete, MEDLINE with Full Text, and APA PsycINFO. I also searched for peer-reviewed journals, dissertations, Sage journals, articles, and fact sheets with Google Scholar, Google, the CDC, the WHO, ADA, American Association of Diabetes Educators, and health publications. The Walden Library was my primary resource for databases for the literature review. I limited most of my search to recent materials from 2016 to 2021, but I also used older articles that were pertinent to my study.

I also focused on the following terms, which were searched individually or with combined options: *self-perceived health (SPH) status*, *blood glucose monitoring (BGM), glycated hemoglobin test (Hba1c test)*, *diabetes self-management* or *self-care, diabetes care by healthcare professionals*, *self-diabetes management*, *clinical diabetes care/management*, *physical activity* or *exercise, dietary or nutrition management*, *medical adherence* or *compliance, footcare* or *foot examination, access to care* or *health care* or *healthcare systems, diabetes chronic care model*, *research designs and self-management of diabetes*, *health literacy*, and *family support system*. Search field functions, such as publication date, full text, subject type, and databases, were applied to obtain more specific articles.

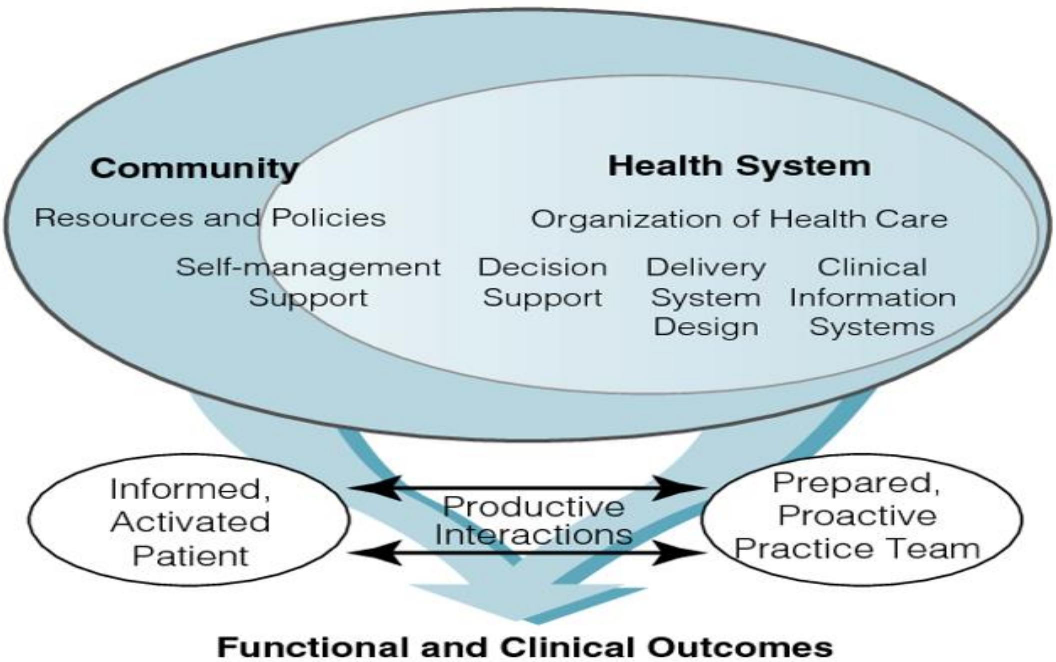
The literature review produced several qualitative, quantitative, and mixed research approaches that influenced diabetes management. Previous studies show that diabetes self-management requires BGM, HbA1c tests, dietary management, physical activities, and medication adherence. It also showed that well-managed diabetes might reduce complications and improve outcomes and overall quality of life. However, it is unclear in the literature review whether there are associations between BGM and HbA1c tests and self-perceived status among adults with diabetes in the United States.

Theoretical Foundation

The theoretical perspective used in this study is the CCM, which Wagner developed in 1998 to improve and guide the interactions between health care system functions and chronic disease management (Si et al., 2008). CCM was derived from reviews and synthesis of interventions in various settings across multiple chronic disease conditions and health care systems (Bustamente et al., 2018). The components of CCM include self-management support, delivery system design, decision, and clinical information system (Si et al., 2008; see Figure 1).

Figure 1

Components of Chronic Care Model



Note. Adapted from “Chronic Disease Management: What Will it Take to Improve Care for Chronic Illness?” by E. H. Wagner, 1998, *Effective Clinical Practice*, *1*, p. 3.

CCM’s objective is to advance an integrated care plan that eliminates disease management fragmentations while improving health outcomes (Stellefson et al., 2013). Since its development, CCM has been widely used in health care settings to improve diabetes management and health care system functions (Si et al., 2008). Diabetes management needs a health care system and care model based on structure, patient-centered, and integrated stakeholders in diabetes care (Kadu & Stolee, 2015). The CCM framework provides the foundation to evaluate the association between the adequacies of diabetes management and clinical diabetes management and health status.

The self-management support construct emphasizes the importance of the patient's engagement in managing their care, like the diabetes management variable's objective evaluated in this study. CCM allows patients to help make informed decisions concerning the care of their health condition (Blumental et al., 2016). To perform self-care responsibility, people with diabetes need to have the ability and skills to engage in modified behaviors, including BGM, glucose hemoglobin testing, regular exercise, and a healthy diet to achieve diabetes control and optimal health outcomes. The construct meets the goals of diabetes self-management education, which enhances the knowledge and abilities of people living with diabetes to modify behaviors to reduce the complications of diabetes, improve health outcomes and quality of life. Effective diabetes self-management facilitates how individuals cope with the challenges to maintain glycemic control and improve quality of life. Diabetes self-management also requires that individuals engage in activities that promote and improve health, such as provider-to-patient interactions. The self-management support construct informed the evaluation of the impact of BGM on SPH status among adults living with diabetes in the United States.

The health care system construct provides guidance on program planning that involves measurable goals for better chronic disease outcomes. The health care system construct helps establish diabetes management training programs to help identify individuals at risk of developing complications and improve clinical and behavioral outcomes (Stellefson et al., 2013). Reforming the health care system to improve the health care model for diabetic patients is essential to diabetes management (Molayaghobi et al., 2019). According to the ADA (2019), CCM supports the need to redefine the health care delivery team's roles and empower patient self-management of diabetes. Health care professionals' evidence-based diabetes research and care protocols, clinical services, and educational practices have improved outcomes that benefit diabetes patients (Stellefson et al., 2013). Further, the CCM, with a specific focus on diabetes, has been effective in several health care settings in the United States compared to other translated evidence models (Blumenthal et al., 2016). The health care system constructs guided the evaluation of the impact of HbA1c testing on SPH status among adults living with diabetes.

The strengths of CCM include evidence-based tools and synthesis of system changes to guide quality improvement in chronic disease management, adequate health care delivery system, and facilitation of self-management of care. The CCM has improved the quality of care of patients and populations while controlling for cost and allocation of resources (Kirsh & Aron, 2016). The limitation is that CCM is new in the health care system, implemented since 2001, compared to other conceptual models used and evaluated for decades. In the future, the impact of chronic illness management such as diabetes on health care and medical costs may motivate health care systems to apply CCM constructs to improve diabetes patient care and outcomes.

I selected the CCM to guide my study approach in addressing my research questions and study variables. The primary goals of diabetes management are to ensure glycemic control and improve health-related quality of life-related to the CCM elements. The CCM elements focus on enabling diabetes self-management, improving clinical diabetes management, and promoting health status (Davy et al., 2015). Evaluating the research variables, BGM, HbA1c test, and SPH status may enable health care providers and health care systems to formulate strategic interventions to improve diabetes management among adults in the United States. The theoretical model and selected constructs guided the investigation of the associations between BGM, HbA1c test, and SPH status to improve self-care and preventive actions for individuals at risk for diabetes and its complications.

Literature Review

In this section, I review the literature on diabetes management and SPH status. Diabetes management is reported as the fundamental element of diabetes care. However, how BGM and HbA1c tests affect SPH status among adults in the United States is unknown. The literature review includes diabetes self-management, health care systems, diabetes self-management education, BGM, HbA1c tests, physical activity, dietary management, medication adherence, foot care, and eye exams. I selected these topics because, despite the increasing prevalence and complications of diabetes, previous research has not explored the association between BGM, HbA1c tests, and SPH status among adults in the United States.

SPH Status

Diabetes plays a significant role in the way individuals with the disease perceive their health status and general well-being. Diabetes is detrimental to a patient's overall health, resulting in a poor perception of health status compared to the general population. Given the increasing risk and burden of diabetes, there should be measures to promote awareness of diabetes risk factors to avoid misperception or underestimation of the disease (Kowall et al., 2017). An individuals' perception of general health is a strong prediction of morbidity and mortality, even after controlling for age, gender, and socioeconomic status (Mwinnyaa et al., 2018).

The primary goal of Healthy People 2020 is to decrease the prevalence and burden of diabetes and improve health-related quality of life for individuals with diabetes (Milo & Connelly, 2018). Therefore, understanding patients' SPH status relating to diabetes is vital in achieving and maintaining glycemic control and enabling health care providers to design intervention programs to improve outcomes. SPH is widely used in the public health field to mitigate the prevalence of chronic diseases and health-related risk factors as a subjective health status assessment. SPH status is also used to measure individual and population health when objective health measurements are unavailable. SPH reflects the underlying disease burden and, therefore, may predict mortality (Lorem et al., 2020).

SPH is consistent with objective health status and can be used to measure health status in the general population and is a predictor of mortality and morbidity of various health conditions. SPH is a viable forecaster of overall physical health because it can capture other elements of poor health that would otherwise be undetected through biomedical or clinical procedures (Mwinnyaa et al., 2018). SPH can be used as an assessment tool to prevent chronic health conditions, including diabetes, among high-risk populations (Yang et al., 2018). Additionally, the association between perceptions of risk diabetes to actual risk differs significantly by race, affecting diabetes prevalence and outcome (Yang et al., 2018). SPH is also associated with age, gender, and educational level, which I explore later in this review (Kowall et al., 2017). The recognition and understanding of how race and ethnicity impact individuals' perceptions of diabetes risk will enable personalized intervention strategies. There are some health problems that clinical assessments cannot diagnose, hence the WHO recommendations to use SPH to assess individuals' general health (Mwinnyaa et al., 2018).

The Impact of Age

Older adults represent the fastest-growing diabetes population and have become a rising public health burden (Kalyani et al., 2013). As life expectancy increases, the population of older people also increases, though aging is one of the risk factors of diabetes and its complications (Chia et al., 2018). Evidence shows that older people tend to decline in glucose tolerance due to increased sedentary lifestyles and less physical activity (Kirkman et al., 2012). The CDC projects that the prevalence of diabetes will double in the next two decades due to the aging population. Diabetes is associated with an increased risk of adverse health conditions affecting decisions whether glycemic control would be beneficial or not among older adults diagnosed with the disease (Kirkman et al., 2010).

Additionally, SPH status inversely correlates with age (Bonner et al., 2017). As a predictor of mortality and morbidity, SPH status influences the demands and utilization of health services, providing vital information to meet the changing needs of the aging population. Further, the absence of chronic conditions such as diabetes is predictive of good self-reported health in the 65-age group and above, and the absence of chronic health conditions in the younger age group has demonstrated the strongest association with self-perceived good health. The subjective health of the population decreases with age, which is consistent with existing knowledge that age was a risk factor for negative SPH (Wu et al., 2013). Older people, like younger adults, would benefit from a glycemic goal of less than 7% of glycated glucose value to prevent diabetes complications (Kalyani & Egan, 2013; Kirkman et al., 2012). Nevertheless, the ADA and the American Geriatrics Society recommend that a patient-centered approach based on health status is more relevant for older adults with diabetes.

The Impact of Race

The measurement of glucose is critical to effective diabetes management and treatment. BGM has improved glycemic control, health status, and quality of life among diabetes patients (Danne et al., 2017). Glycated glucose level is regarded as the gold standard in the assessment of glycemic control, and the values are associated with the complications of diabetes. However, the test cannot detect hypoglycemia or hyperglycemia daily (Danne et al., 2017). Glycated glucose values need to be used in considerations with other criteria for the screening and diagnosing of diabetes (Herman & Cohen, 2012). Regular BGM personalizes diabetes management and provides immediate blood glucose values for hypoglycemia alarms and trends, thereby reducing the risk of hypoglycemic events (Janapala, 2019). However, both glucose measurement methods help maintain glycemic control, keep the blood levels normal, and prevent complications of diabetes such as cardiovascular disease, nephrology, retinopathy, and amputation of extremities.

Evidence suggests that variations of HbA1c levels among race groups might affect the diagnose of diabetes in all ethnic populations. Though some biological conditions may affect the interpretation and use of HbA1c levels, disparities in access to healthcare and quality of diabetes care account for significant variations among race groups and populations (Cavagnolli et al., 2017). Absolute glycated glucose values were higher in Black (0.26%), Asian (0.24%), and Latino (0.08) persons when compared to White individuals. Factors other than blood glucose levels, glycemic control, and access to health care or quality of diabetes care might account for the differences in glycated glucose levels for the ethnic groups and populations (Cavagnolli et al., 2017). Though it is known that glycated glucose levels are lower in Whites than other ethnic groups, ethnicity does not modify the association between glycated glucose levels and diabetes complications among all populations (Cavagnolli et al., 2017). However, it is still unknown how the difference in glycated glucose levels of ethnic groups could impact the diagnosis, monitoring, and treatment of individuals with diabetes, warranting the need to understand the variations in glycated glucose levels due to race to improve the clinical use and management.

Differences in SPH status based on race have been reported in several patient populations. Thomas et al. (2010) suggested that Blacks were likely to report a poor SPH status than whites (15% versus 11%; *OR* = 1.88; $p < .001$). A post-high school education increased the odds of rating poor SPH among blacks (*OR* = 1.86; 95% confidence interval [*CI*] (1.07. 3.24), $p = .3$), though education was not related to SPH in Whites. The authors also noted that SPH status correlated closely with objective clinical health status among Whites than Blacks. The study's findings agreed with existing literature showing that poor SPH correlated more with poor clinical health status and mortality in Whites than Blacks. Thomas et al. (2010) suggested that pessimistic views on health by Blacks adversely impact expected outcomes from clinical management. In addition, diabetes screening, prevention, and healthcare services are low among Blacks than Whites. The authors also suggested that race/ethnicity is essential for understanding disparities in clinical care and designing culturally sensitive interventions to address racial health disparities in diabetes. The study by (Thomas et al., 2010) was a cross-sectional study of diabetes patients and cannot be generalized to a healthy population. Another limitation was a low representation of Blacks and other ethnic groups than Whites in the sample size. Bombak and Bruce (2012) stated that it is important to understand the role race plays in how individuals rate their health status to allow for a more dependable cross-ethnic comparison and understanding of health disparities to enable culturally-tailored intervention programs. It is vital to understand how ethnicity and cultures influence the perception of health when evaluating health disparities within ethnic groups,

The Impact of Gender

Gender-related differences affect the incidence, prevalence, risk factors, and treatment of many diseases, including diabetes (Mauvais-Jarvis, 2017). Kautzky-Willer et al. (2015) noted that women are at a higher risk of low blood glucose levels than men, aligning with previous findings. The differences in glycemic control were suggested to occur because of dissimilarities in body fat distribution and hormones affecting glucose metabolism in women. Women tend to have lower skeletal muscle and higher fatty tissues and other biochemical contents than men of the same age and physical health. These differences have predisposed women to insulin resistance affecting glycemic control (Mauvais-Jarvis, 2017). Understanding gender-related differences are important in selecting an appropriate intervention plan for diabetes patients. Kautzky-Willer, Kosi, and Mihalievic (2015) found that although women weigh less, their body mass index and insulin dose are higher compared to men (BMI< 28kg/m2, $p<0.001$; BMI> 28kg/m2, $p=0.002$). The authors also found that HbA1c levels of (<7%) tend to be lower in men than women for patients who received insulin treatment from baseline (33% of men vs. 26.5% of women; $p < 0.001$), and that women are more likely than men to have lower blood glucose than normal (*OR* 1.80; 95% *CI* 1.08, 3.00; $p = 0.02$). Regular BGM in women will improve glycemic control and prevent diabetes complications (Kautzky-Willer et al., 2015).

Choe, Kim, and Cho (2018) also suggested that men are more likely than women to reach glycemic goals underscoring the need for a gender-specific approach in diabetes management. Therefore, there is a need to monitor diabetes women more closely due to gender differences and vulnerabilities in maintaining glycemic control. This consideration is important as people with diabetes are found to have different disease outcomes. The study by Choe, Kim, and Cho (2018) was a retrospective cohort, subject to the loss of participants. However, the study's findings may be relevant to healthcare professionals due to the large sample size.

Another gender difference affecting blood glucose levels is that diabetes management and treatment are not gender-specific, resulting in differences in treatment responses, risk factors, and outcomes. Arnetz et al. (2014) noted that women are less likely to meet HbA1c targets than men despite having a better diet and practicing regular BGM. The authors shared the argument with Kautzky-Willer et al. (2015) that gender differences in diabetes management and responses are based on biological and socio-physiological factors, including BMI, hormonal changes, and lifestyles. Furthermore, men are more likely to reach glycemic goals than women, but they are more likely to have excessive blood glucose levels and be hospitalized with diabetes-related conditions (Arnetz et al., 2014).

Glucose metabolic disorders are associated with increased mortality, diminished quality of life, and productivity (Kautzky-Willer et al., 2015). In the study to assess gender differences in mortality and morbidity in diabetes patients, Krag et al. (2016) noted that in routine diabetes management, women had reduced mortality and diabetes-related outcome than men. In gender-related diabetes behaviors, women tend to report negative SPH status, utilize healthcare more, diet but exercise less than men. However, gender differences in diabetes behavior and disease outcome do not impact the benefits of diabetes interventions for all genders. While Women implement disease management plans efficiently, which might impact outcomes, men are challenged by daily considerations and behavioral changes due to diabetes. Krag et al. (2016) study is a post hoc study with observational findings, but the result is generalizable to a larger diabetes population.

The Role of Education

BGM plays a vital role in keeping glucose levels within target ranges and in reducing diabetes complications. HbA1c tests provide a sense of glycemic control within two to three months. Contrarily, BGM requires keeping track of glucose results, date and time, medications and doses, and other treatment plans and goals. Self-diabetes management requires individuals with diabetes to have the knowledge and skills to understand their routines and responsibilities in their diabetes care (Weinstock et al., 2021).

Diabetes education enables patients to understand their blood glucose values and adjust food and medication intake to control glucose levels (Kumah-Crystal & Mulvaney, 2013). Regular blood glucose values influence treatment plans suitable for the individual patient. Psychosocial factors, including stress, anxiety, and perceived susceptibility over glycemic variabilities, may result in negative self-perception of health. The authors suggested improving education and skills to support patients with diabetes in BGM to facilitate self and clinical diabetes care.

Diabetes also impacts how individuals with the disease perceive their health status. Therefore, understanding a patient's SPH status is vital to achieving glycemic control, improving disease outcomes, and improving quality of life. SPH status is not only a measure of population health, a predictor of risk factors of mortality and healthcare utilization; it is an integral part of general health and quality of life (Kartal & Inci, 2011). Evidence shows that increased education and higher income are indicators of good health. On the contrary, low education, age, and gender income are associated with poor health and a negative perception of quality of life.

HbA1c test is critical in diabetes management as it is a reliable measure of glycemic control and health status for diabetes patients. Importantly, glycemic control values correlate with the patient's perception of health, and the information is vital to design intervention plans and treatment (Kartal & Inci, 2011). The authors suggested a statistically significant gender difference between good and poor SPH status, females, and males (good: 59.3 vs. 56.9, poor: 40.7 vs. 41.2). Also, education and age showed significant differences between good and poor SPH status. No education (good: 34%, poor 67%), high/college education (good: 81% and poor: 20%. Age <50 (good: 81%, poor: 19%). Age > 50 (good: 48%, poor: 53%). Toci et al. (2015) suggested that socioeconomic factors impact health status, and there is a correlation between SPH and self-reported morbidity among older adults. Low education, poverty, and chronic health conditions are common among vulnerable populations and may impact how SPH is reported in the group.

Evidence also shows that chronic diseases such as diabetes negatively impact patients' health, making them report poor SPH compared to the general population. Individuals diagnosed with diabetes have a low perception of quality of life and health status compared to those with no diagnosis of diabetes (Kartal & Inci, 2011). Though self-perception of health is subjective, it has become a valuable public health tool to assess an individual and a community's health status and quality of life (Cite). SPH status also enables healthcare professionals to devise intervention and treatment plans to mitigate complications, improve health outcomes and quality of life. Though demographic factors, including race, age, gender, and education, were presented as confounding variables in the study, the relationships between the demographics and SPH status were explored in the literature review section.

The practice of diabetes self-management activities requires acquiring knowledge and abilities to engage in appropriate behaviors to optimize health outcomes. McCleary and Jones (2011) suggested that the knowledge of a diabetes patient and the level of health literacy should be considered to facilitate successful management of the disease. Programs designed to improve self-management activities should be developed with people who use them and are sensitive to cultural preferences. The researcher recommended that further research focus on culturally sensitive strategies to enhance health literacy and diabetes self-management practices to improve health outcomes. Given the increasing prevalence of diabetes and the severity of the complications among minority groups and the general population, it is essential to incorporate tailored cultural strategies in diabetes self-management programs to promote individuals' ability to access and utilize diabetes-care information. Overall, diabetes self-management education and health literacy directly impact diabetes and related outcomes and costs. The researchers' central issue is that diabetes education and patients' willingness are essential to improving outcomes and life quality.

The Impact of Poverty Level

Several studies have shown that diabetes disproportionately affects vulnerable populations, including low-income groups, racial and ethnic communities. Poverty is one of the constructs of socioeconomic status, a predictor of the incidence and prevalence of many disease conditions, including diabetes. Socioeconomic status is associated with access to healthcare, healthy food, and environmental services (Hill-Briggs, 2021). Economic status is often measured by an individual's income, household, or community, and individuals with low-income experience more diabetes complications and mortality. Hill-Briggs (2021) noted a widening disparity in diabetes prevalence associated with income. Low income was associated with higher levels of HbA1c and an increased risk of diabetes complications. Compared with high-income people, low-income individuals are less likely to be insured. They may lack healthcare access, impacting their ability to receive diabetes care such as BGM and HbA1c tests. Poverty may also result in a diabetes individual reducing or delaying their medications due to cost.

Adequate understanding of SPH determinants could provide essential information to health promotion programs (Ian Andrew, 2017). Social causation models explain that persons in lower socioeconomic status strata are subject to poor housing, poor nutrition, inadequate education, and access to medical services that trigger poorer health outcomes. Bonner et al. (2017) noted that individuals aged 65 and above, and in the highest income bracket ($80,000), were 1.94 times more likely to report good health than those in the same age group with low income. Wu et al. (2013) noted that individuals with higher income are more optimistic about their health due to indulgence in healthy lifestyles and behaviors than individuals with low income, associated with poor SPH. Bonner et al. (2017) study a cross-sectional design that focuses on associations and not causation. The study was also not representative of the population as some communities and groups of individuals were excluded.

Although SPH is lauded as a good predictor of health status, mortality, and morbidity, it is considered an inferior indicator of population health when compared to objective health measures such as clinical diagnoses and identifications. It is essential to understand the inequities in SPH and the factors contributing to it. The study may add to the existing literature by focusing specifically on demographic characteristics and socioeconomics and how the factors impact diabetes patients with SPH status.

Health Care System

No single intervention plan is appropriate for all individuals with diabetes. That means that diabetes patients should access healthcare systems and treatment plans to achieve optimal glucose levels, including self-monitoring of blood glucose, self-management training and resources, laboratory evaluations, and medical dietary therapy. Diabetes self-management education and skills are needed to enable individuals with diabetes to access appropriate medical care to prevent diabetes complications, achieve optimal glucose control, and reduce the disease's economic burden (AMA, 2012). Though diabetes self-management is critical to maintaining glycemic control in individuals, access to proper medications, equipment, and supplies should be available to enable patients to comply with treatment and therapy goals in their daily lives. Healthcare professionals should also be aware of the diversity in the manifestation and impacts of diabetes upon patients and tailor treatment plans to individual patients (AMA, 2012). The high cost of diabetes in terms of economic burden and complications underscores the need to manage the disease properly.

As the cornerstone of treatment, diabetes management can prevent complications and reduce direct medical costs. Ferdinand and Nasser (2015) noted that racial and ethnic inequalities in diabetes care and hospitalization rate make healthcare delivery and the outcome more complicated, often explaining the high diabetes complications in minority communities. Ferdinand and Nasser (2015) suggested that reducing healthcare disparities should include patient satisfaction surveys and cultural competency assessments. However, broader intervention programs and approaches are required to improve diabetes outcomes and promote healthy behaviors among patients and communities.

Contrary to the perception that the high cost of health impedes healthcare access, Nicklett et al. (2017) argued that access-related barriers were not associated with worse diabetes management. In the cross-sectional study to evaluate the association between healthcare access and diabetes management, the authors found that other than copay expenses with glycated glucose testing, no other access-related factors were significantly associated with diabetes management (-0.86 (0.38) *, [-1.61, -0.11]. Titus and Kataoka-Yahiro (2019) disagreed with the findings of Nicklett et al. (2017), noting that the inability to eat healthy food and lack of access to daily exercise was access to healthcare barriers among low-income Hispanics. However, Titus and Kataoka-Yahiro (2019) recommended that future studies examine if Hispanics with access to care control diets and physical activities better.

According to the CDC (2017), evidence-based behavioral programs, including dietary management, physical activity, and weight loss, can potentially delay or prevent type 2 diabetes in individuals with prediabetes. The underserved communities report higher utilization of emergency and home health visits than individuals with easy access to hospitals, transportation services, and the ability to pay for out-of-pocket expenses. The study's limitation is the lack of randomization of samples and accurate representation of the underserved health care beneficiaries with diabetes. The research is essential for policy planning and intervention programs to improve the future care of individuals with diabetes who may lack access to health care.

BGM and HbA1c Test

The American Association of Diabetes Educators and the ADA recommended that individuals with diabetes engage in regular BGM for effective self-care and optimal outcomes (ADA, 2015). Continuous blood glucose testing provides glucose levels and trends that allow users to prevent and treat hypoglycemia sooner. However, few studies identified issues with the accuracy and malfunctions of glucose monitoring devices.

Diabetes self-management is fundamental to achieving optimal health outcomes and requires BGM, HbA1c test, dietary management, physical activities, and adherence to medication regimens. However, differences in observed outcomes may include race/ethnicity and disparities in access to healthcare systems. Raffle et al. (2012) conducted a study to assess the factors contributing to effective diabetes self-management behaviors in the Appalachian region, as evidenced by regular BGM. Based on their findings (F [8, 3630] = 2.57, $p<.01$), the authors suggested that for successful self-management to be achieved, individuals with diabetes should be aware and understand behaviors that need to be incorporated into their daily lives and activities. A successful diabetes self-management goal is to optimize glycemic control, thereby reducing complications and disease burden. The authors also found that the financial circumstances do not impede successful diabetes self-management as measured by BGM in the Appalachian region.

Physical Activity

Physical activity as a construct of diabetes management is the engagement in physical activities or recreations other than regular job duties. Daily physical activity is an essential part of the self-management of diabetes, along with diet and medications in the prevention and management of type 2 diabetes. Unfortunately, many individuals with the disease find it challenging to be regularly active (Colberg et al., 2016). Evidence shows that active engagement in physical activities may improve glycemic control, reduce diabetes complications, and improve life quality. Both moderate and intense physical activities have been shown to reduce the risk of developing T2D and improve quality of life. Moderate to vigorous exercise may reduce diabetes risk by up to 46%, compared with diet and exercise at 42%, and diet alone at 31% (Colberg et al., 2016).

Engaging in structured physical exercises is vital for glycemic control, reducing diabetes complications, and the overall health of individuals with diabetes. However, physical activity regimen should be tailored to the individuals and diabetes type (Colberg et al., 2016). Adults with diabetes need to perform regular aerobic and resistance exercises for optimal glycemic control and health outcomes. Physical activity and dietary management interventions reduce diabetes and body weight while improving cardiovascular and metabolic functions. Adults with diabetes are encouraged to indulge in 150 minutes or moderate to intense physical activity at least three days every week. It is recommended that a careful evaluation of an individual's medical and physical history and other factors be considered in determining the appropriate level of physical exercises to engage in or avoid (Colberg et al., 2016).

Dietary Management

Evidence shows that reducing fat and caloric amounts in diet can significantly lower the body mass, resulting in weight loss and improved diabetes outcomes. The dietary goal for adults with diabetes is to improve blood glucose levels, reduce body weight, and improve cardiovascular risk factors. An adequate nutritional regimen for diabetes should consider the culture, socioeconomic environment, and comorbidities, among other factors (Evert, 2019). According to the ADA, the dietary goal for individuals with diabetes should be centered on improving and maintaining glycemic targets, achieving weight management goals, and improving cardiovascular risk factors in line with customized treatment goals. ADA also recommends that medical nutrition therapy be dynamic with changes in health status, life stages, other treatment goals, including medication and physical activity (Evert et al., 2019).

Many individuals with diabetes continue to experience challenges with meeting treatment plans and goals despite advances in diabetes care, including effective medications and delivery devices, blood sugar monitoring, and measuring devices. The challenges range from individual needs and situations, lack of skills and resources, and the healthcare system where diabetes patients receive care and services. Peyrot et al. (2018) noted that diabetes self-management requires daily decisions regarding diet, physical activity, BGM, foot examinations, and medication use. Given the disproportionality of individuals with diabetes in minority communities and the disparities in healthcare access, the authors found that, across ethnic groups, the desire to improve self-management was higher for healthy dietary management (73%) than physical exercise (69%), medication adherence (46%), and BGM at 46%. The overall score of healthy eating and physical activities was higher among Chinese and Hispanic Americans than non-Hispanic Whites and African Americans. Across all ethnic groups, self-management efforts were highest in medication use, healthy dietary management, foot care, intermediate blood sugar monitoring, and lowest in physical activities. Peyrot et al. (2018) concluded that healthcare professionals should use patient-oriented approaches and consider ethnicity in tailoring self-management support. The study is an effort to evaluate and improve self-management behaviors across ethnic groups in the US. The study's limitation is that it is based on self-reported data, and the samples may not represent the ethnic communities from which it was drawn.

Medication Adherence

Medication adherence is the collaborative engagement in a shared acceptable course of behavior to produce a therapeutic outcome (Senteio & Veinot, 2014). Despite effective medications and delivery devices, BGM and meeting treatment goals continue to pose serious challenges for many people with diabetes. The CDC recommends that individuals with diabetes indulge in healthy dietary management and moderate physical activities while taking insulin or other medications. Minority groups report lower medication adherence rates to diabetes management due to a range of factors, including but not limited to personal, economic, social, and cultural barriers (McElfish et al., 2018). The researchers conducted a study with 40 Pacific Islanders and found that the Marshallese encounter sociocultural barriers, including financial difficulties, lack of diabetes disease management, cultural practices that influence medication adherence. 40 to 70% of the study participants reported difficulty paying for medications and other cost-related non-adherence, which showed cost-related barriers as significant for diabetes patients. However, while about 70% of the participants reported difficulty with medication payments and cost-related non-adherence, only 25% requested low-cost medications. The findings were consistent with the body of knowledge that shows the importance of access to healthcare for diabetes patients to achieve medication adherence among minority communities.

Also, Patel et al. (2018) noted that financial burden is a significant concern for individuals engaged in self-management of diabetes. The authors suggested that healthcare systems' focus on price transparency and lowering insurance costs had diverted attention and intervention to address cost-related issues to improve medication adherence. Furthermore, Patel et al. (2018) also argued that financial barrier is a significant deterrent to medication adherence, which manifests in dosage reduction, frequency, and delays in filling prescriptions. These cost-related management behaviors result in worse glycemic control, declining functioning, and increased hospitalization rates.

Evidence-based and measurable interventions are needed to address the broader financial challenges adults with diabetes experience. Despite Medicaid expansion and health insurance reform efforts, minority populations, including African Americans, have continued to experience diabetes management challenges and access to care (Glenn et al., 2020). The authors noted that African Americans are more likely to abandon or delay seeking medical care and services due to cost, resulting in poor health outcomes. African Americans are also less likely to comply with diabetes medication and treatment plans and, therefore, experience worse health outcomes more quickly (Senteio & Veinot, 2014).

Other compounding difficulties in diabetes management and medication adherence include transportation and competing family priorities to utilize healthcare services and the lack of access to diabetes preventive care and services. Glenn et al. (2020) argued that the high rate of poorly controlled diabetes among minority groups reflects disparities. Moreover, that active participation in healthcare services would lead to better outcomes and reduced overall healthcare costs. Sommers, Maylene, Blandonet al. (2017) argued that the expansion of healthcare coverage has led to an increase in accessibility and affordability ($p<0.05$) and quality ($p<0.10$), which has translated into reduced cost-related delays in both care and medication use. However, the expansion of coverage has also increased the difficulty of obtaining visits with specialists. Coverage expansion regarding utilization and preventive care increased in glucose screening (25%), cholesterol monitoring, and self-reported health-related diabetes management. There were also significant reductions in emergency visits (28%), but no significant changes were noted with hospitalization and out-of-pocket expenses among high-risk patients with diabetes.

In 2018, Bustamente et al. used a cross-national sample of older adults to examine the relationship between access to healthcare, the healthcare system, and diabetes self-management activities in LA and CDMX. The authors found that social support is a statistically significant predictor of improved diabetes self-management (37%–51%, $p < 0.05$), especially in the context of treatment, testing, and access to care. The research supported existing findings that the limited health care system and access represent a barrier to diabetes self-management. According to the CCM framework, differences in accessing healthcare systems will impact managing diabetes conditions (Bustamente et al., 2018). Vaccaro and Huffman (2012) also observed that Mexican and African Americans tend to have limited access and utilization of quality health care, even when controlling for insurance and income status. The authors stated that it is essential for individuals with diabetes to acquire adequate diabetes self-management skills to lower diabetes-related complications.

Individuals without healthcare coverage may not be receiving enough guidance and advice necessary to manage their diabetes regarding glycemic control, dietary intake, weight management, foot and eye care. To attain and maintain optimal diabetes health outcomes, individuals must engage in self-management behaviors, such as a healthy diet, regular physical activities, BGM, medication adherence, and foot care. Optimizing these behaviors in adults with diabetes may improve outcomes and reduce the risk of disease-related complications (Smalls et al., 2014). The diabetes self-care was assessed with other items, including diet, physical activities, BGM, medication adherence, and foot care. These authors found that social support ($r = 0.31$, $p < 0.001$) and access to healthy food ($r = -0.20$, $p = 0.001$) were significantly associated with diabetes self-care and should be considered in future intervention plans.

Foot Care

Many endocrinologists consider foot care as paramount for diabetes care, but most people with diabetes do not practice adequate self-footcare. According to the National Institute of Health and Clinical Excellence (NICE) guidance, individuals with diabetes and their health care professionals should have a regular foot care regimen to check for nerve damage, ulcers, or poor circulation. NICE also recommends that individuals with elevated blood glucose levels and diabetes engage in the daily foot care plan and report any concerns to their healthcare providers. According to Lynch, Strom, and Egede (2011), the national goal for improving diabetes care should include self-management and access to care, such as primary care and specialty healthcare services. Lynch et al. (2011) analyzed the 2007 BRFSS based on 10570 veterans with diabetes to examine diabetes care among veterans' populations in rural versus urban areas. The study results demonstrated that 74% of rural veterans versus 64% of urban veterans were more likely to have foot care or examination. Sixty-three percent of urban veterans versus 59% of rural veterans were more likely to have blood glucose testing regularly. Self-management activities were slighter higher among rural veterans than their urban counterparts, though provider-based quality care was not significantly different between the two groups. Lynch et al. (2011) findings were consistent with previous research on self-management activities and health care utilization among veterans since about 94% of them have health insurance.

Evidence shows that the progression of diabetes complications can be reduced by preventive care or self-care, such as BGM or foot care. However, a concern exists that diabetes preventive care is suboptimal, especially in underserved communities and rural areas. A cross-sectional analysis of the 2008-2010 BRFSS was conducted by Sohn et al. (2016) to evaluate disparities in receiving preventive care between Appalachian and non-Appalachian counties and within Appalachian counties. Sohn et al. (2016) found significant disparities in socioeconomic status and access to care factors. Suboptimal care was received by those in distressed counties with limited access to preventive care due to physicians' unavailability or podiatrists. Also, 24% of those in distressed counties perceived cost as a barrier to medical care to 11% in competitive counties. Distressed counties in the Appalachian region had a 68% annual foot examination compared to 77.8% of those in competitive counties ($p<0.001$, all comparisons). It is also important to note that at-risk counties exceeded self-care behaviors, as demonstrated by 71% of daily glucose checks versus 63.9% in competitive counties. Also, daily foot self-care was 72.5% higher in distressed counties than 69.7% in competitive counties in the Appalachian region. Sohn et al. (2016) noted significant disparities in healthcare access and clinical services such as annual foot examinations and blood glucose tests. They also reported no self-care disparities based on daily foot care and blood glucose monitor. The findings were consistent with previous studies that improving health care access could reduce disparities in preventive care for diabetes management.

Eye Exam

Annual eye dilation examination performed by health care professionals for retinopathy screening. Diabetic retinopathies are progressive complications with an increased risk of loss of vision or blindness. The American Association of Diabetes Educators and the ADA recommend annual dilated eye examinations for individuals diagnosed with diabetes to prevent visual impairment and blindness (ADA, 2015). Unfortunately, many individuals with diabetes do not receive the eye care, and education recommended to mitigate diabetic retinopathies (Beaser et al., 2018). Benoit et al. (2019) found that the frequency of eye exams is low and suggestive of a systemic change in the health care systems. The authors used multinomial logistic regression to assess the relationship between the frequency of eye examination visits and diabetes duration. Forty-eight percent of 298383 patients with diabetes and no diabetic retinopathy did not receive eye exams over the study period. Only 15.4% met the ADA's recommendation for an annual or biennial eye examination. 11.2 % of 13215 patients diagnosed with diabetes and diabetes retinopathy did not have eye examination visits over the study period, though 51% met the ADA recommendations for an annual eye exam. Out of 355384 subjects, only 41.6% of diabetes patients with no diabetic retinopathy met the ADA recommendation for annual or biennial eye exams. Clinical eye care is even lower in minority populations and individuals with low socioeconomic status.

Though many factors were responsible for low eye care utilization by Benoit et al. (2019), clinical referral rates were found to be suboptimal by the authors. The limitations of the study include a lack of laboratory results and accurate clinical diagnoses. Also, the sample size was large, but it was not representative of the overall population. Also, eye care utilization varies by race and ethnicity, and such information was not available for the study. The authors recommended changes in the healthcare systems to address suboptimal eye care usage among individuals with diabetes.

Summary and Conclusions

The literature review produced several qualitative, quantitative, and mixed research approaches that influenced diabetes management practices. The literary review identified vital factors that influence diabetes management in both minority groups and the general population. The independent variables (BGM and HbA1c tests), the dependent variables (SPH status), and the confounding variables, including race/ethnicity, age, gender, education, and poverty, play crucial roles in diabetes management.

The CCM frameworks provided the foundation for researchers to evaluate their perceptions and interactions with their knowledge and behavior. CCM posits that improved functional and clinical outcomes for disease management result from productive collaborations and engagements between patients and healthcare professionals. Many studies have been conducted and intervention programs created for diabetes and how individuals understand and process the disease's knowledge. Though several studies have been conducted on diabetes and its complications, there is a need to understand the disease's continued prevalence in the general population, especially among minority and vulnerable groups.

The impact of demographic characteristics on SPH status was explored. Evidence shows that the diagnosis of diabetes may lead to poor perception of health status among individuals with the disease. Also, the SPH status of a population influences health service utilization, mortality, and morbidity rates. Understanding SPH status relating to diabetes is a crucial tool in achieving and maintaining glycemic control. It enables healthcare providers to design intervention programs to improve outcomes, quality of life and reduce the complications associated with the disease.

Though several studies acknowledged that diabetes self-management is fundamental to achieving optimal health outcomes, it was shown that an improved healthcare system for individuals with diabetes might also eliminate the mortality rates and complications. Treatment and therapies that improve blood glucose levels and mitigate diabetes complications may also significantly reduce health care costs. Though self-management is critical to maintaining glycemic control in individuals, access to proper medications, equipment, and supplies should be available to enable patients to comply with treatment and therapy goals in their daily lives. Healthcare professionals should also be aware of the diversity in the manifestation and impacts of diabetes upon patients and tailor treatment plans to individual patients.

Physical activity was the predominant predictor of reduced diabetes risk, even when weight loss goals are not achieved. Engaging in structured physical exercises is vital for glycemic control, reducing diabetes complications, and the overall health of individuals with diabetes. Physical exercise has associated risk factors with diabetes, such as cardiac events, hypoglycemia, and hyperglycemia. However, the risk of an adverse event is considered minimal in low and moderate levels of activities.

The dietary goal for adults with diabetes should be centered on improving and maintaining glycemic targets, achieving weight management goals, and improving cardiovascular risk factors in line with customized treatment goals. Diabetes self-management requires daily diet, physical activity, BGM, foot examinations, and medication use. Given the disproportionality of individuals with diabetes in minority communities and the disparities in healthcare access, the desire to improve self-management was higher for healthy dietary management (73%), physical exercise (69%), medication adherence (46%), and BGM at 46% across all ethnic groups.

The financial burden is a significant concern for individuals engaged in diabetes self-management, especially with out-of-pocket expenses, copays, and cost-sharing for supplies, medications, health care visits, physical activity, or access to healthy food. Minority groups report lower medication adherence rates to diabetes management due to numerous factors, including personal, economic, social, and cultural barriers. Individuals without healthcare coverage may not be receiving enough guidance and advice necessary to manage their diabetes regarding glycemic control, dietary intake, weight management, foot, and eye care. It was also observed that financial circumstances do not impede successful diabetes self-management as measured by BGM in the Appalachian region.

Foot care and eye exams are considered minimal risk, and most diabetes individuals do not practice adequate self-care. Evidence shows that the progression of diabetes complications can be reduced by preventive care and self-care, such as BGM or foot check. However, a concern exists that diabetes preventive care is suboptimal, especially in underserved communities and rural areas. Many individuals with diabetes do not receive recommended eye care and education to mitigate diabetic retinopathies. Though many factors were responsible for low eye care utilization, clinical referral rates were suboptimal. Eye care utilization varies by race and ethnicity, and it was recommended that changes in the healthcare systems address suboptimal eye care usage among individuals with diabetes.

Major limitations in the existing literature are the lack of randomization of samples and accurate representation of the underserved health care beneficiaries with diabetes, even with large sample sizes. The use of cross-sectional designs also made it challenging to associate diabetes quality of life and other variables. Another limitation noted in the current literature is the lack of clarity with general literacy and the role of each form of literacy in diabetes knowledge and self-management behaviors. I plan to utilize numerical data and statistical analyses to evaluate the associations between BGM, HbA1c tests, and SPH status.

My study findings may add to the body of knowledge if the association between BGM, HbA1c tests, and SPH status among adults in the United States is known. The knowledge was gained by evaluating individuals' responses, whether they regularly monitored their blood glucose levels and checked their HbA1c levels at least twice a year, and how that impacts their SPH status. The research design, rationale, and methodology of the study were discussed in chapter three.

Chapter 3: Research Method

I conducted quantitative, cross-sectional research to evaluate whether BGM and HbA1c tests are associated with SPH status among adults with diabetes in the United States. I explored the associations between the independent variables BGM and HbA1c tests and the dependent variable SPH status. I also examined if race modifies the association between BGM and SPH status. This chapter provides the methodology, including the sample population, the sampling method, data collection, instrumentation, data sources and management, and data analysis plan.

Research Design and Rationale

I employed a quantitative and cross-sectional design for my study. I used secondary data from the 2019 National BRFSS surveys to assess the associations between the independent variables (BGM and HbA1c tests) and the dependent variable (SPH status). Quantitative research was appropriate for this study because of the use of data and measurement scales to conduct statistical analyses using SPSS (Ansari et al., 2016). A cross-sectional design was used to assess the prevalence and burden of diabetes among adults in the United States in 2019. The cross-sectional design enabled the estimation of the prevalence of diabetes and the demographic characteristics in the target population (Alexander et al., 2015). Understanding these associations helps facilitate the design of interventions to reduce the prevalence of diabetes, improve health outcomes, and promote quality of life for adults with diabetes in the United States.

Methodology

The research method evaluated the association between BGM, HbA1c test, and SPH status among diabetic adults in the United States. I used ordinal logistic regressions to evaluate the relationships between BGM, HbA1c test, and SPH status, respectively. Moderation analysis was also used to determine the role of race/ethnicity in the association between BGM and SPH status.

Population

In the study, I conducted a secondary data analysis using datasets from the 2019 BRFSS surveys. My sample size was *n* = 418,268 respondents from the United States, including the District of Columbia, Guam, and Puerto Rico, though New Jersey was excluded because it did not have the required data for inclusion (CDC, 2019). The study population includes adults 18 years and older who are diagnosed with diabetes as reported in the BRFSS dataset. The sample population consisted of male and female respondents with no differentiation based on sex or gender in the study analyses.

Power Analysis

The G*Power software version 3.1.9.4 was used to calculate the sample size for each research question. A *z* test was selected for logistic regressions. The power analysis was computed a priori for the sample size using power level, effect size, and goodness-of-fit. The 2019 BRFSS dataset have 418,268 respondents, which were all used as cases for my analyses.

Research Question 1 null hypothesis: In the context of diabetes management, BGM is not associated with SPH status among adults in the United States after controlling for age, gender, race/ethnicity, education, and poverty level. A power level of 95% was selected to capture a more representative sample size. The *p* value was at 0.05 to decide whether to reject or fail to reject the null hypothesis. An effect size of 0.5 was selected to ensure that the observed difference in statistical analyses is significant and did not occur by chance (Meera, 2021). The goodness of fit was set at 0.0 due to no modifying variables. Based on the G*Power version 3.1.9.4 calculation of the sample size, there was a 95% chance of correctly rejecting the null hypothesis that BGM was not associated with SPH status with 988 participants. The final sample size used in the statistical analysis for the BGM variable was 25,780 cases, representing 6.1% of the total number of cases (*n*=418,268).

Research Question 1 alternative hypothesis: In the context of diabetes management, BGM is associated with SPH status among adults in the United States after controlling for age, gender, race/ethnicity, education, and poverty level. A power level of 95% was selected, the *p* value was set at 0.05, an effect size of 0.5 was selected, and the goodness of fit was set at 0.0 due to no modifying variables. Based on the G*Power version 3.1.9.4 calculation of the sample size, there was a 95% chance of not rejecting the null hypothesis when BGM was associated with SPH status with 988 participants. The final sample size used in the statistical analysis for BGM variable was 25,780 cases.

Research Question 2 null hypothesis: In the context of diabetes management, HbA1c tests are not associated with SPH status among adults in the United States after controlling for age, gender, race/ethnicity, education, and poverty level. A power level of 95% was selected, the *p* value was set at 0.05, an effect size of 0.5 was selected, and the goodness of fit was set at 0.0 due to no modifying variables. Based on the G*Power version 3.1.9.4 calculation of the sample size, there was a 95% chance of correctly rejecting the null hypothesis that HbA1c tests were not associated with SPH status with 988 participants. The final sample size used in the statistical analysis for the HbA1c tests variable was 25,779 cases, representing 6.1% of the total number of cases (*n*=418,268).

Research Question 2 alternative hypothesis: In the context of diabetes management, HbA1c tests are associated with SPH status among adults in the United States after controlling for age, gender, race, education, and poverty level. A power level of 95% was selected, the *p* value was set at 0.05, an effect size of 0.5 was selected, and the goodness of fit was set at 0.0 due to no modifying variables. Based on the G*Power version 3.1.9.4 calculation of the sample size, there was a 95% chance of correctly rejecting the null hypothesis that the HbA1c tests were not associated with SPH status with 988 participants. The final sample size used in the statistical analysis for the HbA1c tests variable was 25,779 cases.

Research Question 3 null hypothesis: Race will not modify the association between BGM and SPH status among adults in the United States after controlling for age, gender, education, and poverty level. A 95% power level was selected, the *p* value was set at 0.05, and the goodness of fit of 0.5 was selected. Based on the G*Power version 3.1.9.4 calculation of the sample size, there was a 95% chance of correctly rejecting the null hypothesis that race will not modify the association between BGM and SPH status with 1,975 participants. The final sample size used in the moderation analysis was 25,780 cases, representing 6.1% of the total number of cases (*n*=418,268).

Research Question 3 alternative hypothesis: Race will not modify the association between BGM and SPH status among adults in the United States after controlling for age, gender, education, and poverty level. A 95% power level was selected, the *p* value was set at 0.05, and the goodness of fit of 0.5 was selected. Based on the G*Power calculation of the sample size, there was a 95% chance of correctly rejecting the null hypothesis that race will modify the association between BGM with SPH status with 1,975 participants. The final sample size used in the moderation analysis was 25,780 cases.

Sampling and Sampling Procedures

The BRFSS sample design consists of a random telephone survey sampling, geographic stratifications, random digit, dialing, and a computer-assisted telephone interviewing system. The sampling technique considers the number of adults and telephone lines in the household, cluster size, stratum size, and age/race/sex demographics. The BRFSS uses a disproportionate stratified sample design for landline telephone samples and A random sample design for cellular telephone surveys. Disproportionate stratified sample design allows dividing telephone numbers into two strata sampled separately to obtain a probability sample of all households with telephone lines. Participants who are eligible for BRFSS include adults 18 years and older living in households or college housing. Eligible individuals living in group residences and vacation homes are excluded from the land telephone survey but included cellular phone surveys (CDC, 2020).

Sampling weighting for BRFSS includes the IPF, also known as raking, and design weights. Data weighting allows for more representation and characteristics of the population from which the data was obtained. IPF incorporates cellular survey data and allows for more demographic characteristics that reflect populations' sample distribution at state and local levels. IPF weight adjusts for age, race, sex, and other demographic variables to significantly reduce non-coverage and non-response biases at state levels. Design weights account for the probability of selection and adjustment of non-response bias and non-coverage errors. BRFSS also uses raking to adjust for demographic differences among individuals sampled and the population they represent (CDC, 2020).

The limitation of telephone surveys is a potential for non-coverage errors due to the inability to reach some households. Telephone coverage may be lower to population subgroups due to socioeconomic status, poor health, and a younger household head. Self-reported data also has the potential for under-reporting than information based on physical measurements. Despite the limitations, BRFSS data are dependable, valid, and correspond with data based on face-to-face interviews such as National Health Interview Survey and the National Health and Nutrition Examination Survey.

Procedures for Data Collection (Secondary Data)

I selected the National BRFSS datasets because they are the primary sources of timely and accurate data for major health-related reports (Arizona Department of Health Services and Bureau of Tobacco and Chronic Disease, 2017). The BRFSS collects U.S. residents' data concerning health-related behavioral risks, chronic conditions, preventive health practices, and health care access to chronic diseases and injury. BRFSS data are collected annually at the state and local levels to promote healthy activities and disease prevention initiatives (CDC, 2020). National and state health departments use BRFSS data to identify, design, implement, evaluate critical health issues, propose health policies, measure progress toward health objectives, and monitor preventive disease programs (CDC, 2020). The BRFSS survey also collects demographic data, such as race/ethnicity, gender, income, and education attainment. The data collected from BRFSS are de-identified to protect the participants' privacy and confidentiality.

I obtained the National BRFSS datasets from the CDC website. I reviewed the datasets and the codebook and saved them on my personal computer. The 2019 BRFSS dataset have 418,268 respondents from surveillance surveys by landline telephone and cellphone from 50 states of America, including the District of Columbia, Guam, and Puerto Rico. New Jersey was excluded from the 2019 BRFSS data because it did not have the required data for inclusion (CDC, 2019). The responses in the 2019 BRFSS data were self-reported. The selected variables for my study analyses include RBGM, HbA1c test, SPH status, and Race.

The sample methods used for 2019 BRFSS data include a disproportionate stratified sample, which is commonly used for landline telephone sampling, and the simple random sample design used for Guam and Puerto Rico. The cellphone sampling frames are based on the database of commercially available telephone exchanges. The target population for cellphone samples in 2019 consists of individuals in private residences or college housing. The computer-assisted telephone interview system was used in 2019 for data collection.

Instrumentation

The 2019 BRFSS survey is an instrument that was used to collect data for this study. The BRFSS surveys have standardized questions to assess the prevalence of risk factors for various diseases, quality of life, and changes in the population's risk (CDC, 2020). The 2019 BRFSS questionnaires have 23 modules of core content questions, sets of questions on specific topics, and state-added questions to address specific needs, which could last an average of 25 to 30 minutes. The core portion of the BRFSS questionnaire could last up to 18 minutes, and other added questions from states may add another 5 to 10 minutes, bringing the total survey time to 25 to 30 minutes.

The instrument was suitable for this study because the survey is a significant source of state-level public health data for health planning promotion and disease prevention. The surveillance system also estimates the prevalence of health behaviors and conditions and monitors preventive disease programs. The states rely on the BRFSS self-reported database to capture and evaluate the prevalence of diabetes in the population.

Data Operationalization

In the BRFSS dataset, the names of the study variables were retained according to their functions in the study. The name of one variable was changed from the general health status to the SPH status in this study. Table 1 describes the operational names and functions of the independent and dependent variables. The table includes the names of the variables been evaluated, the measurement scale, the questions, and responses as selected from the BRFSS dataset, the response interpretations, and the confounding variable used.

Table 1

Independent and Dependent Variables

Variable	Measurement	RQ	Responses	Interpretations	Confounding variables
BGM	Ordinal	Do you monitor your blood glucose level regularly, including when family members and friends help you to do so?	1 = regular 2 = not regular 3 = never	1 = good SPH 2 = fair SPH 3 = poor SPH	Race/ethnicity, age, gender, education, and poverty level
HbA1c test	Ordinal	Have you seen a provider 2 times or more in the past 12 months for an HbA1c test?	1 = two times or more 2 = two times or less 3 = never	1 = good SPH 2 = fair SPH 3 = poor SPH	Race/ethnicity, age, gender, education, and poverty level
Dependent Variable					
SPH	Ordinal	How would you describe your general health status?	1 = good 2 = fair 3 = poor	1 = good SPH 2 = fair SPH 3 = poor SPH	Race/ethnicity, age, gender, education, and poverty level
Moderating Variable for RQ 3					
Race/ethnicity 1 = White 2 = Black 3 = Asian 4 = A/Indian 5 = Hispanic 6 = Other	Scale	Does race/ethnicity modify the association between regular BGM and SPH?	N/A	Moderation effect	Age, gender, education, and poverty level

Data Analysis Plan

I conducted a secondary data analysis using the national BRFSS datasets and the Statistical Package for the Social Science (SPSS) version 27, which is a package that enables researchers to conduct statistical analyses. As discussed later in the section, SPSS was used to generate descriptive data statistics and statistical analyses for logistic regressions.

Research Questions and Hypotheses

The research questions and hypotheses were used to evaluate the association between BGM, HbA1c test, and SPH status as selected in the BRFSS dataset.

RQ1: In the context of diabetes management, how is BGM associated with SPH status among adults in the United States while controlling for age, gender, race/ethnicity, education, and poverty level?

$H_0$1: In the context of diabetes management, BGM is not associated with SPH status among adults in the United States after controlling for age, gender, race/ethnicity, education, and poverty level.

$H_1$1: In the context of diabetes management, BGM is associated with SPH status among adults in the United States after controlling for age, gender, race/ethnicity, education, and poverty level.

RQ2: In the context of diabetes management, how is the HbA1c test associated with SPH status among adults in the United States while controlling for age, race/ethnicity, gender, education, and poverty level?

$H_0$2: In the context of diabetes management, HbA1c tests are not associated with SPH status among adults in the United States after controlling for age, gender, race/ethnicity, education, and poverty level.

$H_1$2: In the context of diabetes management, HbA1c tests are associated with SPH status among adults in the United States after controlling for age, gender, race/ethnicity, education, and poverty level.

RQ3: Does race modify the association between BGM and SPH status after controlling for age, gender, education, and poverty level?

$H_0$3: Race/ethnicity will not modify the association between BGM and SPH status among adults in the United States after controlling for age, gender, education, and poverty level.

$H_1$3: Race/ethnicity will modify the association between BGM and SPH status among adults in the United States after controlling for age, gender, education, and poverty level.

Statistical Tests

The data analysis plan to evaluate each research question included the use of ordinal logistic regressions to conduct the statistical analysis for research questions 1 and 2 and a moderation analysis for research question 3. I also used the generalized linear models as a secondary process of ordinal logistic regressions for a robust test of model effects and parameter-estimate outputs. I conducted a bivariate analysis for each research question to determine the relationship between the variables' existence, strength, and direction. The analyses were conducted using the Statistical Package for the Social Science (SPSS) software version 27.

In Research Question 1, ordinal logistic regression was employed to evaluate the association between BGM and SPH status. The independent and dependent variables for Research Question 1 were BGM and SPH status. The result was considered significant if the *p*-value was less than 0.05 (p <0.05). Suppose the ordinal logistic regression result was less than the *p*-value (p <0.05), it would mean an association exists between BGM and SPH status. Also, it may be interpreted that the BGM variable would improve SPH status. On the other hand, if the ordinal logistic regression result were greater than the *p*-value (p >0.05), it would demonstrate that there was no association between BGM and SPH status. It may also be stated that the BGM variable may not improve SPH status.

Additionally, *OR* was used to reflect changes in the odds of being in a higher category on the SPH status for every value increase on the RBGM, holding confounding variables constant. An *OR* greater than 1 or less than 1 suggests an increasing or decreasing probability of being at a higher level on the SPH status variable as values on the BGM increase or decrease. An *OR* equal to 1 suggests no predicted change in the likelihood of being in a higher category as values on BGM increase or decrease.

Ordinal logistic regression was used for research question #2 ($H_0$2 and $H_1$2) to examine the association between HbA1c tests and SPH status. The independent and dependent variables for research question #2 were HbA1c tests and SPH status, respectively. The result was considered significant if the *p*-value was less than 0.05(p <0.05). If the ordinal logistic regression result were less than the *p*-value ($p < 0.05$), it would mean that an association exists between HbA1c tests and SPH status. It may also be interpreted that the I- HbA1c tests variable would improve SPH status. On the contrary, if the ordinal logistic regression analysis result were greater than the p-value ($p > 0.05$), it would mean that there was no association between HbA1c tests and SPH status. It may also be stated that the HbA1c tests variable may not improve SPH status.

Again, *OR* was used to reflect changes in the odds of being in a higher category on the SPH status variable for every value increase on HbA1c tests test, holding confounding variables constant. An *OR* greater than 1 or less than 1, suggests an increasing or decreasing probability of being at a higher level on the SPH status as values on the HbA1c tests increases or decrease. An *OR* equal to 1, suggests no predicted change in the likelihood of being in a higher category as values on HbA1c tests increases and decrease.

Finally, Research Question 3 was evaluated using a moderation analysis to determine if race modifies the BGM and SPH status variables. The independent and dependent variables for Research Question 3 were regular BGM and SPH status, respectively, with race as a covariate. The result was considered significant if *p*-value was less than 0.5($p < 0.05$). If the result of moderation analysis were less than the *p*-value ($p < 0.05$), it would indicate a positive interaction effect of race on the association between BGM and SPH status. It may also be interpreted that race plays a significant role in the BGM and SPH status association. However, if the result of the moderation analysis were greater than the p-value ($p > 0.05$), it would indicate that an inverse interaction effect of race/ethnicity on the association between BGM and SPH status. It may also suggest that race/ethnicity does not modify the association between BGM and SPH status.

As a statistical tool, ordinal logistic regressions were appropriate for Research Questions 1 and 2 because the independent variables were categorical, while the dependent variable has an ordinal variable with coded responses. Logistic regression reduces the effect of confounding variables and helps to predict the probability of binary events. A moderation analysis was equally appropriate for Research Question 3 as it explained the impact of an independent variable on a dependent variable under the influence of a moderating variable. The assumptions for ordinal logistic regressions include the ordinal level of measurements, a large sample size, no multicollinearity between predictor variables, and no normal distribution of variables (Thanda, 2020). The predictor variables BGM and HbA1c tests were assessed a priori to verify there were no violations of the assumptions. Parameters such as the goodness-of-fit, Log-likelihood, Wald, and *OR* were also calculated to determine the relationships' strength and direction.

Threats to Validity

The validity types discussed are external and internal validity.

External Validity

The external validity signifies the extrapolation of study findings to different populations or samples. The result of my study was not generalizable to a larger population because of the use of secondary data analyses. Also, the use of cross-sectional design allowed me to assess the predictor and outcome variables but did not provide a cause-and-effect relationship. Finally, BRFSS data are based on subjective self-reported responses, which may differ from the objective health status assessments, resulting in a bias (CDC, 2020).

Internal Validity

The internal validity measures how observed effects of dependent variables are attributable to the independent variables. The assumptions for ordinal logistic regression, generalized linear regressions, and moderation analysis were evaluated before conducting the statistical analyses. The assumptions discussed include the levels of measurement for the analytical methods, multicollinearity, sample size and proportion of odds. The assumptions of proportional odds were not met with ordinal logistic regression; I used the generalized linear models to complete my analysis for research questions 1 and 2.

Ethical Procedures

In this study, I conducted a secondary data analysis using the 2019 BRFSS datasets. The use of these datasets eliminated direct contact with human subjects and the requirement for informed consent. The BRFSS data were available in the public domain of the Center for Disease and Prevention website. The data were not derived from any websites belonging to me, and there was no conflict of interest. There was no requirement for a memorandum of understanding for data sharing since datasets were de-identified and anonymous. I also submitted a request to use the 2019 BRFSS dataset to the Institutional Review Board of Walden University (approval no. 06-22-21-0425548).

Summary

The information discussed in chapter 3 defined the methodology employed for this study. The quantitative research method and cross-sectional design were used to explore the association between BGM, HbA1c tests, and self-perceived status among adults with diabetes in the United States. The 2019 BRFSS dataset for the research and the target population groups were also discussed. The process of obtaining the 2019 BRFSS data from the CDC was outlined. Finally, the use of ordinal logistic regression and moderation analyses for my statistical methods were discussed. In chapter 4, the abstract was developed, and the study results and findings were discussed using tables, figures, graphs, and narratives.

Chapter 4: Results

The purpose of this quantitative, cross-sectional study was to examine whether BGM and HbA1c tests are associated with SPH status among adults with diabetes in the United States. I also wanted to examine whether race moderates the association between BGM and SPH status. The knowledge and understanding of the associations may facilitate intervention designs and strategies to improve health outcomes and promote quality of life among diabetes adults. It may allow the understanding of the role of race/ethnicity in the relationship between BGM and SPH status.

In chapter 4, I discuss the data collection process, the statistical analyses performed, the assumptions, and the study results. I described the descriptive statistics for my independent and dependent variables and presented my findings for each research question. Finally, I present the summary and interpretations of the findings of my study and a transition to Chapter 5.

Data Collection

The secondary data used were the 2019 BRFSS dataset, which were available for public use on the CDC website. The 2019 BRFSS datasets are the most recent surveillance data on diabetes and other chronic health conditions from the adult population residing in the United States. The 2019 BRFSS datasets consist of the variables of interest and the sample size needed for this study. After receiving Walden’s Institutional Review Board approval, I downloaded the 2019 BRFSS dataset to my personal computer to be used for this study.

The 2019 BRFSS weighting methodology (also known as raking) includes the design and sociodemographic characteristics of the population, such as race, gender, educational level, income level, marital status, telephone sources, regions, and states. The design weight accounts for the probability of selection and adjustment of nonresponse bias and non-coverage errors. Raking weight is an adjustment of the population based on demographic differences between those samples and the population they represent. The overall goal of data weighting is to ensure that the sample data are representative of the population from which it was drawn.

Pre-Analysis Data Preparations

In SPSS, I selected eight-core study and related variables out of the 342 variables in the 2019 BRFSS dataset. I created the variable view string and numeric values using the SPSS transform function. The BRFSS variable name for general health was renamed SPH status for the study. The variables for BGM and HbA1c tests were recoded from scale to ordinal variables, and the SPH status variable was recoded from scale to an ordinal variable for the research questions. Data cleaning was performed, and the missing values were replaced with the serial mean for BGM, HbA1c tests, and SPH status.

I also downloaded the Hayes Process macro version 3.5 for moderation analysis and saved it on the SPSS software 27. Because the Hayes moderation analysis requires variable names not more than eight-character letters (Crowson, 2020), I renamed the variables for Research Question 3 as BGM for regular BGM and SPH for SPH status in 2019 BRFSS dataset. The variable "race/ethnicity" was retained as a scale measurement for Research Question 3.

Study Results

In this section, I present the statistical analyses and study results, starting with the descriptive and frequency statistics computed with SPSS software version 27. I evaluated the assumptions of the statistical analyses used in the study. I also designated numbers to the outputs tables and separately presented the answers to Research Questions 1–3.

Table 2 presents the descriptive statistics for BGM and HbA1c tests and the dependent variable SPH status. The descriptive statistics provided the necessary values to guide inferences during the study analysis of data. I also used the frequency statistics to characterize the variables of interest, including the valid numbers of each category variable, the missing values, and the mean, mode, standard deviations, range, minimum, and maximum of the variables as shown in Table 3. The frequency statistics were important in the statistical analyses and in answering the three research questions.

Table 2

Descriptive Statistics

	N	Min.	Max.	Mean	*SD*
SPH	**418,268**	**1.00**	**3.00**	**1.2534**	**.54749**
BGM	**418,268**	**1.00**	**3.00**	**1.5601**	**.17776**
HbA1c	**418,268**	**1.00**	**3.00**	**1.1400**	**.09789**
@Race	418,268	1	6	1.70	1.455
Gender	418,268	1.00	3.00	1.5461	.49787
Age	418,268	1.00	3.00	2.3381	.60013
Education level	418,268	1.00	3.00	2.6338	.53064
Poverty level	418,268	1.00	3.00	2.0958	.69160
Valid *N* (listwise)	418,268	1.00	3.00		

Table 3

Frequency Statistics

		SPH1	BGM	HbA1c	@Race	Gender	Age	Education level	Poverty level
N	Valid	**418,268**	**418,268**	**418,268**	418,268	418,268	418,268	418,268	418,268
	Missing	**0**	**0**	**0**	0	0	0	0	0
Mean		**1.2534**	**1.5601**	**1.1400**	1.70	1.5461	2.3381	2.6338	2.0958
Median		**1.0000**	**1.5600**	**1.1400**	1.00	2.0000	2.3381	3.0000	2.0000
Mode		**1.00**	**1.56**	**1.14**	1	2.00	2.34	3.00	2.00
SD		**.54749**	**.17776**	**.09789**	1.455	.49787	.60013	.53064	.69160
Range		**2.00**	**2.00**	**2.00**	5.00	1.00	2.00	2.00	2.00
Min.		**1.00**	**1.00**	**1.00**	1.00	1.00	1.00	1.00	1.00
Max.		**3.00**	**3.00**	**3.00**	6.00	2.00	3.00	3.00	3.00

Assumptions

The five assumptions for ordinal logistic regression and linear regression (moderation analysis) were evaluated to ensure that they were met and that the results were valid. Assumption 1 is that the dependent variable should have ordinal measurements (Walden Academic Skills Center, 2019). This assumption was met with the use of independent and dependent variables for ordinal logistic regression.

Assumption 2 is that the independent variables should have continuous, ordinal, or nominal measurement levels (Walden Academic Skills Center, 2019). This assumption was met as the independent variables BGM, and HbA1c tests were measured at ordinal levels for Research Questions 1 and 2. For Research Question 3, the race variable was measured at a scale level for moderation analyses.

Assumption 3 is no multicollinearity between independent variables (Walden Academic Skills Center, 2019). The assumption was met as the predictors (independent variables) are not correlated and provided independent information in the regression model. Assumption 4 is that there are the proportion of odds (Walden Academic Skills Center, 2019). This assumption was met, as shown later in the study analyses

Finally, Assumption 5 is that the sample size should be large enough to draw sufficient conclusions (Zach, 2020). The assumption was met as demonstrated by the sample sizes in the descriptive statistics table for Research Questions 1, 2, and 3 statistical analyses.

Bivariate Correlation Matrix Analysis for BGM

I followed the following steps for bivariate correlation analysis for BGM:

- Step 1: The number of cases was (n = 418,268).
- Step 2: The correlation between BGM and SPH status was determined to be significant ($p < .01$).
- Step 3: Per the Pearson correlation value (-.024), the direction of the relationship between BGM and SPH status was negative, meaning that lower levels of BGM were associated with higher levels of SPH status.
- Step 4: The correlation coefficient value is r = 0.024, showing a weak relationship between BGM and SPH status (Rockinson-Szapkiw, 2013).
- Step 5: The coefficient of determination was 0.06%, meaning that BGM helped to explain 0.06% of the variance in the scores of SPH status.

A Pearson correlation coefficient was conducted to examine the null hypothesis that there is no association between BGM and SPH status (n = 418,268). There was a significant but negative association between BGM and SPH status (M=1.5601 SD = .17776), (M=

1.2534, *SD*= .54749), *r* (418268) = -.024, *p* <.01. The result means that lower levels of BGM are associated with higher levels of SPH status.

Bivariate Correlation Matrix Analysis for HbA1c

I followed these steps for bivariate correlation for HbA1c:

- Step 1: The number of cases was (*n* = 418,268).
- Step 2: The correlation was determined to be significant ($p < .01$).
- Step 3: Per the Pearson correlation value (-.027), the direction of the relationship between the HbA1c test and SPH status was negative, meaning that lower levels of the HbA1c test are associated with higher levels of SPH status.
- Step 4: The correlation coefficient value is $r = 0.027$, indicating a weak relationship between the HbA1c test and SPH status (Rockinson-Szapkiw, 2013).
- Step 5: The coefficient of determination indicates the extent of variation the variables share. The coefficient of determination was 0.07%, meaning that the HbA1c test helped explain 0.07% of the variance in the scores of SPH status.

A Pearson correlation coefficient was conducted to examine the null hypothesis that there is no association between the HbA1c test and SPH status (*n* = 418,268). There was a significant but negative association between HbA1c test and SPH status (*M* = 1.140, *SD* = .09789), (*M* = 1.2534, *SD* = .54749), *r* (418,268) = -.027, $p < .01$. The result means that lower levels of the HbA1c test are associated with higher levels of SPH status.

Research Question 1

In the context of diabetes management, how is BGM associated with SPH status among adults in the United States after controlling for age, gender, race, education, and poverty level? For Research Question 1, I conducted a bivariate analysis to determine the strength and direction of the relationship between the variables. Then, I conducted an ordinal logistic regression and the generalized linear models as a secondary process of ordinal logistic regression using SPSS version 27 to evaluate the association between BGM and SPH status. The independent and dependent variables for Research Question 1 are BGM and SPH status, which are both the ordinal level of measurements. The *CI* was set at 95%, the effect size of 0.5 was selected, and the *p* value was set at 0.05.

The case processing summary provides a valid score of 418,268 for the independent and dependent variables (see Table 4). Most of the respondents ranked themselves in the good SPH status category (80.2%), and 5.6% of the respondents ranked themselves in the poor SPH status category. Most were in the regular BGM category (3.5%), whereas the lowest scores (1.8%) and (0.8%) were respondents who ranked themselves in the irregular BGM and never categories, respectively. Gender was a confounding variable but included in the factor category and case processing summary because of the nominal level of measurement.

Table 4

Case Processing Summary for Research Question 1

		N	Marginal percentage
SPH1	Good	335,391	80.2%
	1.25	26	0.0%
	Fair	59,725	14.3%

	Poor	23,126	5.5%
BGM	Regular	14,749	3.5%
	1.56	392,488	93.8%
	Irregular	7,597	1.8%
	Never	3,434	0.8%
Gender1	1.00	189,835	45.4%
	2.00	228,433	56.6%
Valid		418,268	100.0%
Missing		0	
Total		418,268	

The model fitting information compared the model against the null hypothesis. The -2-log likelihood calculation captured the sum of the probabilities associated with the predicted and actual values. The output for the -2-log likelihood model and full model indicates that the model was a statistically significant improvement in fit of the final model than the null hypothesis, LR X^2 (8) = 41,338.349, $p < 0.05$.

The goodness of fit model contains the Pearson and deviance chi-square tests, which exhibit a good fit to the data. In this analysis, both the Pearson and Deviance tests were significant at $p < 0.05$, demonstrating that the output was not a well-fitting model. Pearson chi-square [X^2 (5,695) = 66,755.310, $p < 0.05$] and the deviance chi-square [X^2 (5,695) = 11,563.039, $p < 0.05$], respectively. The goodness-of-fit was significant ($p <$ 0.05), indicating that the model was not correctly specified, resulting in the rejection of the null hypothesis.

The Pseudo R^2 includes the Cox & Snell, Nagelkerke, and McFadden values, which were used to calculate the explained variations. The Cox & Snell and McFadden values of .094 and .080 respectively demonstrated that the independent variable has a similar weight in the model. The explained variation in the dependent variable was noted in the Nagelkerke R^2 index. The overall model had a weak relationship (Nagelkerke R^2 =

.133) that explained 13.3 % of the variance for SPH status, signaling the rejection of the null hypothesis.

I used route-2 of the ordinal logistic regression to conduct the tests of model effects (see Table 5). The chi-square likelihood ratio indicates the overall contribution of the independent variables to the model. The independent variable, BGM, and the confounding variables, education level, poverty level, race/ethnicity, gender, and age, were statistically significant predictors and contributed to the model at $p < 0.05$. The likelihood ratio chi-square for BGM was [$X^2 = 5{,}388.956$, $p < 0.05$].

Table 5

Test of Model Effects for Research Question 1

Source	Likelihood ratio chi-square	df	Sig.
BGM	5,388.956	3	.000
@Race	182.949[a]	1	.000
Gender	4.026	1	.045
Age	929.943	1	.000
Education level	5,087.350	1	.000
Poverty level	17,591.143[a]	1	.000

Note. Dependent variable = SPH

a. results are shown based on the last iteration

I used route-2 of the ordinal logistic regression to conduct the parameter estimates. The parameter estimates output shows the contribution of each independent variable to the model with their statistical significance (see Table 6). The BGM variable was coded 1 = regular, 2 = irregular and 3 = never (reference category). As shown in the parameter estimates, regular BGM is a positive and significant predictor of SPH status ($B = .224$, $SE = .0388$, $p < .05$). On the other hand, irregular BGM variable is a negative but significant predictor of SPH status ($B = -.139$, $SE = .0428$, $p < .05$).

Table 6

Parameter Estimates for Research Question 1

Parameter	B	SE	95% Wald CI Lower	95% Wald CI Upper	Wald chi-square	df	Sig.	Exp (B)	95% Wald CI for Exp (B) Lower	95% Wald CI for Exp (B) Upper
Threshold										
SPH = good	-1.81	.0450	-1.898	-1.722	1619.5	1	.000	.164	.150	.179
SPH = 1.25	-1.81	.0450	-1.898	-1.721	1619.7	1	.000	.164	.150	.179
SPH = Fair	-.257	.0450	-.345	-.169	32.526	1	.000	.773	.708	.845
BGM = Regular	.224	.0388	.148	.300	33.316	1	.000	1.251	1.160	1.350
BGM = 1.56	-.921	.0355	-.990	-.851	673.43	1	.000	.398	.372	.427
BGM = irregular	-.139	.0428	-.223	-.055	10.596	1	.001	.870	.800	.946
BGM = Never	0[a]							1.00		
@Race	.036	.0026	.031	.041	185.58	1	.000	1.037	1.031	1.042
Gender1	.016	.0082	.000	.032	4.027	1	.045	1.017	1.000	1.033
Gender2	0[a]							1.00		
Age	.218	.0073	.204	.233	906.51	1	.000	1.244	1.227	1.262
Education level	-.523	.0073	-.537	-.509	5171.6	1	.000	.593	.584	.601
Poverty level	-.825	.0063	-.837	-.812	16891	1	.000	.438	.433	.444

Note. Dependent variable = SPH; reference category is SPH = poor

a. The parameter is set to zero because it is redundant

The log *OR* showed the strength of the relationship between two variables: BGM and SPH status (Starmer, 2018). Also, the log *OR* indicates that there is a predicated increase /decrease in the log odds of falling in a higher level of the dependent variable for every one unit increase on an independent variable (Crowson, 2019). Regular BGM in the output indicates that, for every one unit increase of BGM, there is a predicted increase of .224% in the log *OR* of reporting a higher level of SPH status than lower levels for individuals with diabetes who perform BGM regularly. Irregular BGM suggests that for every one unit increase of BGM, there is a predicted decrease of -.139 in the log odds of reporting a higher level of SPH status than lower levels for people with diabetes who do not perform blood glucose regularly. In other words, it is more probable for individuals who perform regular BGM to report a higher category of SPH status compared to people who do not perform regular BGM.

Interpretation of Odds Ratio

The *OR* of regular BGM is *Exp (B)* = 1.251, $p < 0.05$, 95% *CI* (1.160, 1.350), while the *OR* of irregular BGM is Exp (B) = .870, $p < 0.05$, 95% *CI* (.800, .946). The *OR* reflects the multiple changes in the odds of being in a higher category on the dependent variable for every one unit increase on the independent variable, holding the confounding variables constant. An *OR* greater than 1 or less than 1, suggests an increasing or decreasing probability of being at a higher level on the dependent variable as values on the independent variables increases. An *OR* of 1, suggests no predicted change in the likelihood of being in a higher category as values on independent variables increase (Crowson, 2019).

Regular BGM show that the *OR* of reporting in a higher level on SPH status increased by 1.251 for every one unit increase of BGM [*Exp (B)* = 1.251, $p < 0.05$, 95% *CI* (1.160, 1.350)]. Irregular BGM also demonstrates that the *OR* of reporting a higher level on SPH status decreased by .870 for every one unit increase of BGM [*Exp (B)* = .870, $p < 0.05$, 95% *CI* (.800, .946). This means an increased probability of reporting in a higher category on SPH status for individuals with diabetes who perform regular BGM than those who do not perform regular BGM.

The test of parallel lines was used to assess the slope coefficient in the proportional odds to ensure that the *OR*s were the same across all levels of the SPH status (outcome) variable. The test of parallel lines output was not statistically significant ($p >$ 0.05; see Table 7), which agreed with the assumption of the proportion of odds.

Table 7

Test of Parallel Lines[a] for Research Question 1

Model	-2 Log likelihood	Chi-square	df	Sig.
Null hypothesis	36.961			
General	36.941	.020	1	**.888**

Note. The null hypothesis states that the location parameters (slope coefficients) are the same across response categories

a. Link function: logit

The 95% *CI* of regular BGM is (1.160, 1.350), while the 95% *CI* for irregular BGM is (.800, .946). The 95% *CI* indicates that the *OR* falls within the lower and upper limits of the true population (Crowson, 2019). The 95% confidence level for regular BGM (1.160, 1.350) and the slope of the variable do not contain an overlap of p <0.05, indicating that the null hypothesis should be rejected (Dun, 2016). Also, the 95%

confidence level for the observed internal values (.800, .946) for irregular BGM does not contain an overlap of p <0.05.

Based on the result of the analyses, the statistical significance of *p*-value ($p <$ 0.05), log odds, the *OR*, and the 95% *CI* for the regular BGM category, the null hypothesis was rejected in favor of the alternate hypothesis. Also, the *p*-value (p <0.05), log odds, the *OR*, and the 95% *CI* for irregular BGM category, the null hypothesis was rejected in favor of the alternate hypothesis.

Result Analysis for Research Question 1

Ordinal logistic regression was conducted to investigate Research Question 1: In the context of diabetes management, how is BGM associated with SPH status among adults with diabetes in the United States after controlling for age, gender, race, education, and poverty level? The predictor variable, BGM, was assessed a priori to evaluate the assumptions. The model fitting information output for the -2-log likelihood model and full model showed that the model was a statistically significant improvement in fit of the final model over the null model [LR X^2 (8) = 41338.349, p <0.05]. The goodness-of-fit for Pearson chi-square [X^2 (5695) = 66755.310, p <0.05] and Deviance [X^2 (5695) = 11563.039, p <0.05] were significant at $p < 0.05$, demonstrating that the model did not correctly specify the data. Also, the R-Square value (Nagelkereke $R^{2\,=}$ 13.3% explained the variance in the dependent variable (SPH status), which signifies a weak relationship supporting the rejection of the null hypothesis. As shown in the tests of model output, the chi-square likelihood ratio indicates that the independent variable BGM, and the confounding variables, education level, poverty level, race/ethnicity, gender, and age, were statistically significant predictors and contributed to the model at p <0.05. The likelihood ratio chi-square for BGM was [*X2* = 5388.956, p <0.05].

The parameter estimates output showed that regular BGM was a positive predictor and has statistically significant relationship with of SPH status at p < 0.05. The log likelihood [Coefficient *4 (B)* = .224, *S. E*=.0388, Wald = 33.32, p < 0.05] and the *OR* [*Exp (B)* = 1.251, p < 0.05, 95% *CI* (1.160, 1.350)] showed direct proportional relationships between regular BGM and SPH status, controlling for age, gender, race, education, and poverty level. For every one unit increase of BGM, there was an increased probability of 0.224 (log likelihood) and 1.251 (*OR*) of individuals with diabetes who perform regular BGM of reporting a good SPH status compared to those who do not practice regular BGM. The 95% confidence level for regular BGM (1.160, 1.350) and the slope of regular BGM do not contain an overlap of p <0.05, showing that the null hypothesis should be rejected.

The parameter estimates output also showed that the irregular BGM was a negative but significant predictor of SPH at p < 0.05. The log-likelihood for irregular BGM [(*B*) = -.139, *S. E*=.0428, *Wald* = 10.60, p > 0.05] and the *OR* [*Exp (B)* = .870, p < 0.05, 95% *CI* (.800, .946)] showed inverse relationships between irregular BGM and SPH status, controlling for age, gender, race, education, and poverty level. For every one unit increase of BGM, there was a decreased probability of -.139 (log-likelihood) and .870 (*OR*) of individuals with diabetes who do not perform regular BGM of reporting a good SPH status compared to those who practice regular BGM. The 95% confidence level

(.800, .946) and the slope of irregular BGM do not contain an overlap of $p < 0.05$, showing that the null hypothesis should be rejected.

Research Question 2

Research Question 2: In the context of diabetes management, how is the HbA1c test associated with SPH status among adults with diabetes in the United States after controlling for age, race, gender, education, and poverty level? For Research Question 2, I conducted an ordinal logistic regression using SPSS version 27 to evaluate the association between the HbA1c test and SPH status. The independent and dependent variables for research question #2 were the HbA1c test and SPH status. Both variables have ordinal levels of measurement, respectively. The confidence interval was set at 95%, and the *p*-value was set at ($p < 0.05$). The results of the ordinal logistic regression for research question 2 are discussed in this section.

The case processing summary provides the total scores for the independent and dependent variables, which are 418,268 (see Table 8). Eighty-point two percent (80.2%) of the respondents ranked themselves in the good SPH status category (dependent variable). Fourteen-point three (14.3%) and five-point five percent (5.5%) of the respondents ranked themselves in the fair and poor SPH status category (dependent variable), respectively. The next higher number (5.4%) are respondents who ranked themselves in the two times or more HbA1c test category (independent variable), while the lowest scores were respondents who ranked themselves in the one time or less (0.6%) and never (0.1%) HbA1c test category (independent variable), respectively. Gender was a confounding variable but included in the factor category and case summary because of the nominal level of measurement.

Table 8

Case Processing Summary for Research Question 2

		N	Marginal percentage
SPH1	Good	335,391	80.2%
	1.25	26	0.0%
	Fair	59,725	14.3%
	Poor	23,126	5.5%
HbA1c	Two times or more	22,648	5.4%
	1.14	392,489	93.8%
	One time or less	2,672	0.6%
	Never	459	0.1%
Gender1	1.00	189,835	45.4%
	2.00	228,433	56.6%
Valid		418,268	100.0%
Missing		0	
Total		418,268	

The model fitting information output for the -2-log likelihood model and full model showed a statistically significant improvement in fit of the Final model over the null hypothesis [LR X^2 (8) = 41191.919, p <0.05]. The -2-log likelihood calculation indicated that the sum of the probabilities is associated with the predicted and actual values.

The goodness of fit contains the Pearson and deviance chi-square tests, which show whether the model a good fit the data or not. In this analysis, the Pearson and deviance tests were significant at p <0.05, demonstrating that the model does not fit the data well. Pearson chi-square: [X^2 (5074) = 66338.75, p <0.05] and the deviance test: [X^2 (5074) = 11082.728, p <0.05], respectively. The goodness-of-fit was significant (p <0.05) and not a good fit for the data.

The Pseudo R^2 values, the Cox & Snell R Square, and Nagelkerke R Square values were used to calculate the explained variations. The Cox & Snell and McFadden values of .094 and .080, respectively, demonstrated that the model's independent variable has about the same weight. As noted in this model, the explained variation in the dependent variable was based on the Nagelkerke *R2* test. The model had a weak relationship (Nagelkerke $R^{2\,=}$ .132), which explained only 13.2 % of the variance for SPH status.

I used route-2 of the ordinal logistic regression to conduct the test of model effects. The chi-square likelihood ratio indicates the overall contribution of the independent variables to the model. The independent variable, HbA1c, is statistically significant and was found to contribute to the model ($p < 0.05$). The likelihood ratio chi-square is [$X^2 = 5242.526$, $p < 0.05$] for HbA1c (see Table 9).

Table 9

Test of Model Effects for Research Question 2

Source	Likelihood ratio chi-square	df	Sig.
BGM	5,242.526	3	.000
@Race	177.995	1	.000
Gender	3.058[a]	1	.045
Age	932.148	1	.000
Education level	5,062.199	1	.000
Poverty level	17,634.660	1	.000

Note. Dependent variable = SPH

a. results are shown based on the last iteration

I used route-2 of the ordinal logistic regression to conduct the parameter estimates. The parameter estimates output shows the contribution of each independent variable to the model with their statistical significance (see Table 10). The HbA1c test variable was coded 1= two times or more, 2 = one time or less, and 3 = never, which was set as the reference category. As shown in the parameter estimates, the HbA1c test (two times or more) was negative predictor but has a statistically significant association with SPH status *(B)* = -.308, *S.E.*.=.0910, *p* <.05). On the other hand, the HbA1c test (one time or less) was also negative predictor but has a statistically significant association with SPH status *(B)* = -.211, *S.E.*.=.0975, *p* <.05).

Table 10

Parameter Estimates for Research Question 2

Parameter	B	SE	95% Wald CI Lower	95% Wald CI Upper	Wald chi-square	df	Sig.	Exp (B)	95% Wald CI for Exp (B) Lower	95% Wald CI for Exp (B) Upper
Threshold										
SPH = good	-2.20	.0940	-2.379	-2.010	545.191	1	.000	.111	.093	.134
SPH = 1.25	-2.19	.0940	-2.378	-2.010	544.974	1	.000	.111	.093	.134
SPH = Fair	-.642	.0940	-.827	-.458	46.745	1	.000	.526	.438	.632
HbA1c (two times or more)	-.308	.0910	-.487	-.130	11.489	1	.001	.735	.615	.878
HbA1c 1.14	-1.31	.0901	-1.481	-1.128	209.843	1	.000	.271	.227	.324
HbA1c (One time or less)	-.211	.0975	-.402	-.020	4.673	1	.000	.810	.669	.981
HbA1c = Never	0[a]							1.00		
@Race	.036	.0026	.031	.041	185.58	1	.000	1.037	1.031	1.042
Gender1	.016	.0082	.000	.032	4.027	1	.045	1.017	1.000	1.033
Gender2	0[a]							1.00		
Age	.218	.0073	.204	.233	906.51	1	.000	1.244	1.227	1.262
Education level	-.523	.0073	-.537	-.509	5171.6	1	.000	.593	.584	.601
Poverty level	-.825	.0063	-.837	-.812	16891	1	.000	.438	.433	.444

Note. Dependent variable = SPH; reference category is SPH = poor

a. The parameter is set to zero because it is redundant

The log *OR* for HbA1c tests (two times or more) category indicated that, for every one unit increase of HbA1c test, there is a predicted decrease of -.308% in the log *OR* of reporting a higher level on SPH status compared to individuals with diabetes who perform HbA1c test (one time or less). Also, the log *OR* for HbA1c tests (one time or less) category indicated that for every one unit increase of HbA1c test, there is a predicted decrease of -.211% in the log odds of reporting a higher level on SPH status compared to people with diabetes HbA1c test (two times or more). In other words, the log *OR* is decreased [$(B) = -.308$, $SE = .0910$, $p < .05$) $(B) = -.211$, $SE = .0975$, $p < .05$)] for individuals who perform HbA1c test (two times or more) and (one time or less) of reporting in a higher category on SPH status. The log *OR* in this output is also significant as it indicates an inverse association between HbA1c tests and SPH status.

Interpretation of Odds Ratio

The *OR* for HbA1c test (two times or more) is $Exp\ (B) = .735$, $p < 0.05$, 95% *CI* (.615, .878), while the *OR* for HbA1c test (one time or less) is $Exp\ (B) = .810$, $p < 0.05$, 95% *CI* (.669, .981). The *OR* indicates that for every one unit increase of HbA1c test (two times or more), there is a decreased probability of .735 of reporting in a higher level on SPH status [$Exp\ (B) = .735$, $p < 0.05$, 95% *CI* (.615, .878)]. Also, the *OR* shows that for every one unit increase of HbA1c test (one time or less), there is a decreased probability of .810 of reporting in a higher level on SPH status [$Exp\ (B) = .810$, $p < 0.05$, 95% *CI* (.669, .981). The *OR* showed a decreased probability of reporting in a higher level of SPH status for individuals with diabetes who perform HbA1c tests (two times or more) and those who HbA1c tests (one time or less). Both the *OR* and log *OR* indicate inverse relationships between HbA1c tests and SPH status.

The test of parallel lines was used to assess the assumption of the proportion of odds to ensure that the effect of the HbA1c test (predictor) on the *OR*s are identical across all levels of the SPH status (outcome) variable. The test of parallel lines output was not statistically significant (*p* >0 .05), as shown in Table 10, which agreed with the assumption of the proportion of odds.

Table 11

Test of Parallel Lines for Research Question 2

Model	-2 Log likelihood	Chi-square	df	Sig.
Null hypothesis	35.546			
General	35.021	.525	1	**.469**

Note. The null hypothesis states that the location parameters (slope coefficients) are the same across response categories

a. Link function: logit

The 95% *CI* of the HbA1c test (two times or more) is (.615, .878), while the 95% *CI* for the HbA1c test (one time or less) is (.669, .981). The 95% confidence level and observed internal values for both categories do not contain an overlap of *p* <0.05, indicating that the null hypothesis should be rejected (Dun, 2016).

Based on the result of the analyses, the statistical significance of *p*-value (*p* < 0.05), log odds, the *OR*, and the 95% *C1* for HbA1c test (two times or more), the null hypothesis was rejected, and the alternate hypothesis was favored. Also, the *p*-value (*p* <0.05), log odds, the *OR*, and the 95% *C1* for “HbA1c test (one time or less),” the null hypothesis was rejected, and the alternate hypothesis was favored.

Result Analysis Research Question 2

Ordinal logistic regression was conducted to investigate Research Question 2: "In the context of diabetes management, how is HbA1c test associated with SPH status among adults with diabetes in the United States after controlling for age, race, gender, education, and poverty level? The predictor variable, the HbA1c test, was assessed a priori to verify there was no violation of the assumption.

The model fitting information output for the -2 log-likelihood model and full model showed that the model was a statistically significant improvement in fit of the final model over the null model [LR X^2 (8) = 41191.919, p <0.05]. The Goodness-of-Fit for Pearson and Deviance tests were significant at p <0.05, which demonstrated that the model did not correctly specify the data, [X^2 (5074) = 66338.75, p <0.05] and [X^2 (5074) = 11082.728, p <0.05], respectively. The goodness-of-fit output at (p <0.05), indicated that the model did not accurately describe the data, leading to the rejection of the null hypothesis. Also, the R-Square value (Nagelkerke $R^{2\,=}$ 13.2%) explained the variance in the dependent variable (SPH status), signifying a weak relationship. The likelihood ratio Chi-Square showed that the independent variable, the HbA1c test, was a statistically significant predictor and was found to contribute to the model [X^2 = 5242.526, p <0.05] for HbA1c.

The parameter estimates output showed that the HbA1c test (two times or more) category was a significant predictor of SPH at p < 0.05. The log *OR* of HbA1c test (two times or more) (*B*) = -.308, *S. E.*=.0910, *Wald* = 11.489, p < 0.05] and the *OR* [*Exp* (*B*) = .735, p < 0.05, 95% *CI* (.615, .878)] showed an inverse relationship between HbA1c test (two times or more) and SPH status, controlling for age, gender, race, education, and poverty level. For every one unit increase of HbA1c test, there is a decreased probability of -.308 (log *OR*) and .735 (*OR*) of individuals with diabetes who perform HbA1c test (two times or more) of reporting a good SPH status. The 95% confidence level (.615, 878) and the observed internal values for the HbA1c test (two times or more) do not contain an overlap of p <0.05, showing that the null hypothesis should be rejected.

The parameter estimates output also showed that the HbA1c test (one time or less) was a negative predictor but has a statistically significant association with of SPH at p <0.05. The log *OR* for HbA1c test (one time or less) (B) = -.211, *S. E*= .0975, *Wald* = 4.673, p< 0.05] and the *OR* [*Exp (B)* = .810, p < 0.05, 95% *CI* (.669, .981)] showed an inverse relationship between HbA1c test (one time or less) and SPH status, controlling for age, gender, race, education, and poverty level. With every one unit of increase in the HbA1c test (one time or less), there is a decreased probability (.810) of reporting in a higher category on self-deceived health status. Also, the 95% confidence level (.669, .981) and the slope of the category for the HbA1c test (one time or less) do not contain an overlap of p <0.05, indicating that the null hypothesis should be rejected.

Research Question 3

Research Question 3: Does race/ethnicity modify the association between BGM and SPH status after controlling for age, gender, education, and poverty level? I used moderation analysis to answer Research Question 3. A simple conceptual model 1 of Hayes' moderation analysis was selected, the confidence interval was set at 95%, and the moderation and conditioning effects were at p < .05. The conditioning values were at -1

SD, mean, +1SD, and Johnson-Neyman output was selected. The variables, race, and BGM were mean-centered before the analysis, meaning that the product of the two variables was interpretable with the range of the data.

Hayes Conceptual model (1) was used where X is the independent variable (BGM), Y is the dependent variable (SPH status), and W is the moderator variable (race) (Hayes, 2018). In the model summary, R^2 accounted for the predictor variable in the model. The model summary was statistically significant (R^2 = .0046, *F* (648.0), *df* (3.0, 25776.0), $p < 0.05$).

In this model, the unstandardized regression coefficient of the independent variable, BGM, was -.0863, and it is statistically significant at $p < 0.05$. The unstandardized regression coefficient of the moderator variable (race) was .0120, and it is significant at $p < 0.05$. The interaction effect formed as a product of race and BGM has a coefficient of -.0076, and it is significant at .0267 ($p < 0.05$). The result of the model shows that the moderator variable (race) has a positive effect and statistically significant relationship with BGM. But the slope or observed internal values of the 95%*CI* includes a zero within the true population (-.0153, .0135).

The interaction effect formed as a product of race and BGM was R^2 = 0.0001, *F* (1.449), *df* (1.000, 25776.0), $p < 0.05$ (.0267), and was statistically significant. The level of confidence for all *CI*s in the output is 95%. W-values conditional tables are the minimum, the mean, and 1 SD above the mean. One SD below the mean is below the minimum observed in the data for (W), so the minimum measurement on (W) was used for conditioning instead. There were no statistical significance transition points within the observed range of the moderator found using the Johnson-Neyman method. The interaction effect was statistically significant, but as noted in the outcome variable output, zero falls within the lower and upper bounds of the bootstrap *CI* for moderator (@race and the interaction effect (see Table 12). The focal predictor (BGM) was statistically significant, as shown in the output, and zero does not fall with the lower and upper bounds of the bootstrap *CI*s.

Table 12

Output for Outcome Variable Self-Perceived Health

	Coefficient	BootMean	BootSE	BootLLCI	BootULCI
Constant	1.3474	1.3473	.0171	1.3143	1.3820
BGM	-.0863	-.0863	.0110	-.1083	-.0650
@Race	.0120	.0121	.0085	-.0045	.0286
Int-1	.0076	.0076	.0054	-.0029	.0183

Figure 3 represents the levels of interaction effect by race: Whites (green), Blacks (red), Asians (purple), A/Native (dark green), and Others (blue). The six lines of race interactions are like the conditional effect of Johnson-Neyman output (see Figure 2). The graph represents the relationship between BGM and race on the conditional effect of Johnson-Neyman output. The diagonal line from the y-axis to the x-axis is the reference line. The blue line represents the relationship between BGM and SPH status among individuals reporting at (1) SD below the mean (1.00) on race. The green line shows the relationship between BGM and SPH status among individuals at the mean (1.70) of race. The red line represents the relationship between BGM and SPH status among individuals reporting at (1) SD above the mean on race 3.15). The slope has an increasing inverse direction as it moves from low-level interaction to high-level relationship.

Figure 2

Research Question 3 Visual Interpretation

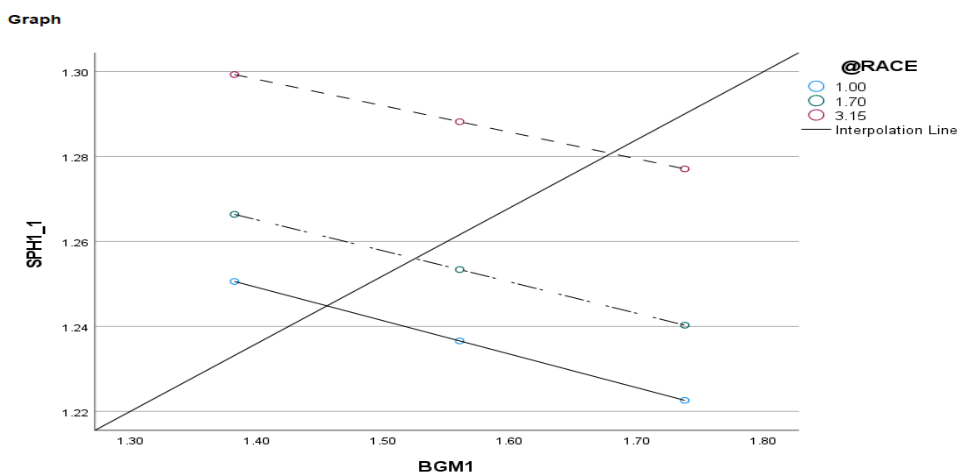
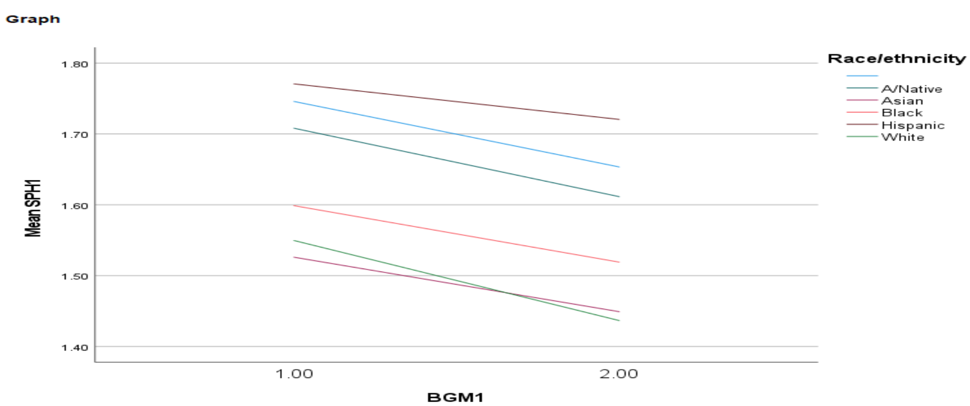


Figure 3

Levels of Interaction by Race



Result Analysis for Research Question 3

To investigate research question 3, I performed a simple moderator analysis using the Process macro (version 3.5). The focal predictor and output variables were BGM and SPH status, respectively. The moderator variable evaluated for the analysis was race/ethnicity. The models showed that the predictor variable (BGM) [(*B*= -.0863, *S.E.*=.0075, *p*<0.05, 95% *CI* (-.1010, -.0717)] and the moderator variable (race) [(*B*.0120, *S.E.*=.0054, *p*<0.05, 95% *CI* (.0014, .0226)] were statistically significant and contributed to the models. The interaction effect between the focal predictor and the moderator variables was statistically significant [(*B*)= .0076, *S.E.*=.0034, *p*<0.05, 95% *CI* (-.0009, .0144)] and [R^2=.0001, *F* (1.449), *df* (1.000, 25776.0), $p < 0.05$ (.0267)].

As indicated, one standard deviation below the mean was less than the minimum observed in the data for the moderator variable. So, the minimum measurement on the moderator variable was used for conditioning instead. Figures 2 and 3 represent the relationship between BGM and SPH status on the conditional effect of Johnson-Neyman output of race. The blue slope characterized the relationship between BGM and SPH status among individuals reporting at (1) SD below the mean (1.00) on race. The green line indicated the association between BGM and SPH status among individuals reporting at the mean (1.70) of race. The red slope represents the relationship between regular BGM and race among individuals reporting at (1) SD above the race's mean (3.15). The slope has an increasing inverse direction as it moves from the low level to the high level of the interactions. In the visual data and graphs for the conditional effect, the moderator variable (@race) was determined to have an increasing inverse direction on the relationship between BGM and SPH status, as evident by the negative slopes for the six levels of race interactions.

Summary

Bivariate analyses, ordinal logistic regression, and generalized linear models were conducted for research question 1 to assess how BGM is associated with SPH status among adults in the United States after controlling for age, gender, race, education, and poverty level in the context of diabetes management. The statistical analyses showed that BGM was a positive predictor and has a statistically significant association with SPH status. The null hypothesis was rejected in favor of the alternate hypothesis. BGM has a statistically significant association with SPH status ($p<.05$) among adults in the United States while controlling for age, gender, race/ethnicity, education, and poverty level.

To examine Research Question 2, I conducted bivariate analyses, ordinal logistic regression, and generalized linear models to assess how the HbA1c test is associated with SPH status among adults in the United States after controlling for age, gender, race, education, and poverty level in the context of diabetes management. The statistical analyses showed that the HbA1c test was a negative predictor but has a statistically significant relationship with SPH status. The null hypothesis was rejected in favor of the alternate hypothesis. HbA1c has a statistically significant association with SPH status ($p<.05$) among adults in the United States while controlling for age, gender, race/ethnicity, education, and poverty level.

To answer Research Question 3, I performed a simple moderator analysis using Process macro (version 3.5) to examine whether race modifies the relationship between blood glucose and SPH status. The result of the moderation analysis model revealed that the relationship between the predictor and the outcome variables was statistically significant. The interaction effect between the predictor variable and the moderator variable was also statistically significant. However, the moderator variable (Race/ethnicity) was determined to have a negative moderating effect on the relationship between BGM and SPH status, as evident by the increasing inverse direction of the slopes in the Johnson-Neyman conditional effect output. The null hypothesis was rejected in favor of the alternate hypothesis. The interaction effect between race and BGM is statistically significant ($p<.05$), but it is either insignificant or has an inverse effect on the SPH status among adults in the United States after controlling for age, gender, education, and poverty level. The slope or observed internal values of the 95%*CI* includes a zero in the true population (-.0153, .0135).

In Chapter 4, I showed the statistical analyses and results of the research questions on the association between BGM, HbA1c test, and SPH status. I also showed the interaction effect of race on the relationship between BGM and SPH status. A summary of data collection, pre-analysis data preparation, descriptive and frequency statistics of the variables were presented. I conducted statistical analyses to answer the three research questions and discussed the statistically significant predictors and those not statistically significant. In chapter 5, I will discuss the interpretations of my findings, limitations of the study, recommendations for future research, and implications of the study results.

Chapter 5: Discussion, Conclusions, and Recommendations

The purpose of my quantitative cross-sectional study was to examine whether BGM and increased HbA1c tests are associated with SPH status among adults with diabetes in the United States. Moreover, I evaluated whether race has a modifying interaction in the association of BGM and SPH status. The confounding variables were age, race, gender, education, and poverty level. I used data from the 2019 National BRFSS consisting of 418,268 respondents to assess the associations between the independent variables (BGM and HbA1c tests) and the dependent variable (SPH status). The understanding and perception of the relationships between the study variables may enable the design of preventive measures and intervention strategies to mitigate the prevalence and complications of diabetes.

Interpretation of Findings

The significant findings of this study include the following: 3.5% of people with diabetes who engage in regular BGM are more likely to report good SPH status (80.2%). On the contrary, 1.8 % of individual diabetes who do not practice regular BGM tend to report a fair or poor SPH status—14.2% and 5.5%, respectively. The results also showed that 5.4% of people with diabetes who met with their providers two times or more in a year for HbA1c tests were more likely to report good SPH status, and 0.6% of diabetic individuals who met with their providers one time or less in a year for HbA1c tests are more likely to report fair or poor SPH status. Another important finding of the study consistent with existing literature is that confounding variables such as age, race, gender, education level, and poverty are likely to contribute to how individuals with diabetes perceive their health status.

As noted in ordinal logistic regression models for Research Question 1, the R^2 values indicated a weak relationship, which explained a 13.3% variance between BGM and SPH status among adults with diabetes in the United States. A 13.2% variance was also noted between the HbA1c test and SPH status, indicating another weak relationship. However, ordinal logistic regression parameter estimates showed that BGM and HbA1c test were statistically significant predictors for SPH status while holding other variables constant. Though both the BGM and HbA1c tests were statistically significant, BGM was a positive predictor, while HbA1c was a negative predictor.

In the model summary for the moderation analysis, the R^2 accounts for the predictor variable; BGM was statistically significant. The interaction effect formed as a product of race and BGM was statistically significant ($R^2 = .0046$, *F* (648.0), *df* (3.0, 25776.0), $p < 0.05$). Additionally, the conditional effect of Johnson-Neyman output showed negative slopes for the interaction effects between race and BGM. The overall result of the moderation analysis shows that the relationship between BGM and SPH status cannot be moderated by race. This result differs from existing knowledge in the literature that race influences SPH status in the context of diabetes management (Thomas et al., 2010).

BGM and SPH

The ordinal logistic regression and generalized linear models showed in Research Question 1 that the BGM variable is a positive predictor and has a statistically significant association with SPH at $p < 0.05$. The log odds and *OR* confirmed that for every one unit increase of BGM, there is an increased probability of an individual with diabetes who performs BGM regularly reporting in a higher category on SPH status than those who perform BGM regularly.

HbA1c and SPH

The ordinal logistic regression and generalized linear models showed in Research Question 2 that the HbA1c tests variable is a negative predictor but has a statistically significant relationship of SPH at $p < 0.05$. The log odds and *OR* also confirmed that for every one unit increase of HbA1c test, there is a decreased probability of individuals with diabetes who perform HbA1c (two times or more, and one time or less) of reporting in a higher category on SPH status.

Race and Regular BGM

The moderation analysis model showed that the relationship between BGM and SPH status variables was statistically significant. The interaction effect between BGM and the race variable was also statistically significant. However, the slope of the relationship between race, BGM and SPH status showed increasing inverse direction as it moved from low to high levels of interactions, hence the negative slopes on the visual graphs (figure 4 & 5).

Limitations of the Study

First, about 6.1 % of 418268 respondents were used to assess the associations between BGM, HbA1c test, and SPH status. First, as a cross-sectional design, the associations between BGM, HbA1c test, and SPH status do not imply causality and should not be generalized to a larger population. Second, as a secondary data analysis based on household telephone surveys, there are potential threats for non-coverage errors that may affect the true sample population (Arizona Department of Health Services and Bureau of Tobacco and Chronic Disease, 2017). Finally, BRFSS data are based on subjective self-reported responses, which may differ from the objective health status assessments, resulting in a bias (CDC, 2020).

Recommendations

Other factors influence diabetes management, such as physical activities, nutritional management, foot care, eye examination, and medication adherence. Social and environmental variables, socioeconomic status, and marital status variables also impact the self-perception of health status. Further studies should explore how these factors impact the self-perception of health status among diabetes populations to enable more strategic interventions to address the prevalence and burden of diabetes and the cost and emergency utilization of care.

The study findings show a statistically significant association between the HbA1c test and SPH and indicate that the HbA1c test was a negative predictor of SPH status. For every unit increase of the HbA1c test, there was a decreased probability of reporting in a higher category on the SPH status. This finding has a significant clinical implication as the HbA1c test is one of the recommended standards of care in diabetes management (ADA, 2018). Further studies using other statistical analytical methods and measurement levels are required to investigate the perception of HbA1c evaluations among individuals with diabetes regarding their general well-being. Also, additional studies are warranted to evaluate the relationship between the confounding variables in this study (age, gender, education, and poverty level) and SPH status.

Implications

The study findings are consistent with existing clinical implications that people with diabetes who do not perform regular glucose monitoring tend to have poor self-perception of health status and are at risk of developing complications from the disease. This group of people with diabetes should be targeted by health care professionals for effective diabetes management plans.

Diabetes is a condition that causes enormous health and economic burden to people with the disease. As shown by this study and previous research, individuals who experience managed glycemic control tend to have good perceptions of health in terms of general wellbeing and quality of life. Individuals with diabetes who do not engage in recommended diabetes management practices and lack glycemic control tend to have poor self-perception of health status and associated poor health conditions. Therefore, it is vital to design clinical interventions and self-empowerment strategies to target specific groups of individuals with diabetes who have fair or poor self-perception of health due to irregularities in diabetes management practices.

The concept of family and social support is integral to diabetes management. Social supports, including emotional, physical, informational, and affirmational supports provided through family network structures to individuals with diabetes, are beneficial. Recent studies have noted the correlation between social support networks and regular BGM. Ravi et al. (2018) suggest that engaging family members and friends in caring for people with diabetes may significantly improve outcomes and quality of life. The results of this study highlight the significance of regular BGM. As noted in the findings, for every unit increase of diabetes management as indicated by the log odds and *OR*, there is an increasing probability of reporting in a higher level on SPH status. It means that as more people with diabetes are motivated through focused intervention programs and social support networks to engage in recommended diabetes management practices, the more they have managed glycemic control, favorable outcomes, reduced complications, improved quality of life, and overall wellbeing.

Diabetes is the seventh leading cause of death and the most expensive chronic condition in the United States (CDC, 2021). The economic cost of diabetes rose 60% from 2007 to 2017, and about 327 billion dollars are spent on medical costs and reduced productivity (CDC, 2021). Most people with diabetes may have a low life expectancy and poor health outcomes if it is not effectively managed. There are policies, campaigns, and mass awareness programs at all levels of society to help prevent the risk factors and complications of diabetes. The findings of this study show the groups of individuals with diabetes to be targeted for a positive social change.

Implication for Analysis and Theoretical Framework

This study shows that diabetes management practices and the confounding variables: age, gender, race, educational level, and poverty level are significantly associated with SPH status. The CCM is a good fit for diabetes management practices because of the emphasis on integrated care plans between patients and healthcare systems to improve health outcomes and quality of life. Stellefson et al. (2013) noted that CCM supports intervention programs to identify individuals at risk of developing diabetes complications for effective diabetes management.

Conclusions

Diabetes is a condition that causes enormous health and economic burden to people with the disease. The prevalence of diabetes and its complications has increased worldwide, with the projection to double in the future. This study shows that individuals with diabetes who experience glycemic control tend to have good perceptions of health in terms of quality of life and general well-being. On the other contrary, individuals with diabetes who do not engage in recommended diabetes management practices tend to lack glycemic control and have poor self-perception of health status. It is therefore important to design clinical interventions and self-empowerment strategies to focus on certain groups of individuals with diabetes who have fair or poor self-perception of health due to irregularities in diabetes management practices.

Also, the findings of this study may add to the body of knowledge on how people with diabetes view the impact of diabetes management practices on the perception of health status. Understanding diabetes management practices and SPH status may enable health care professionals to target specific groups of diabetes adults and intervention programs to reduce the prevalence and complications of diabetes among adults in the United States.

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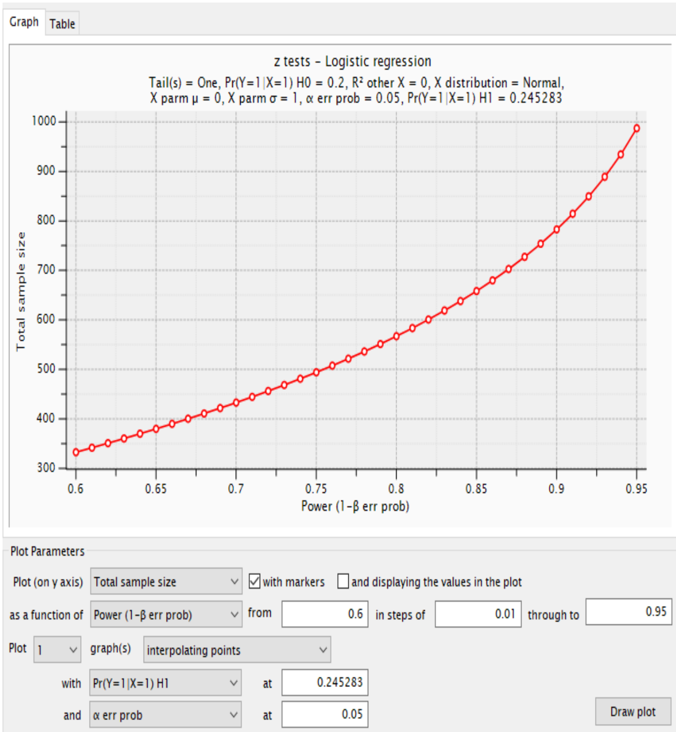
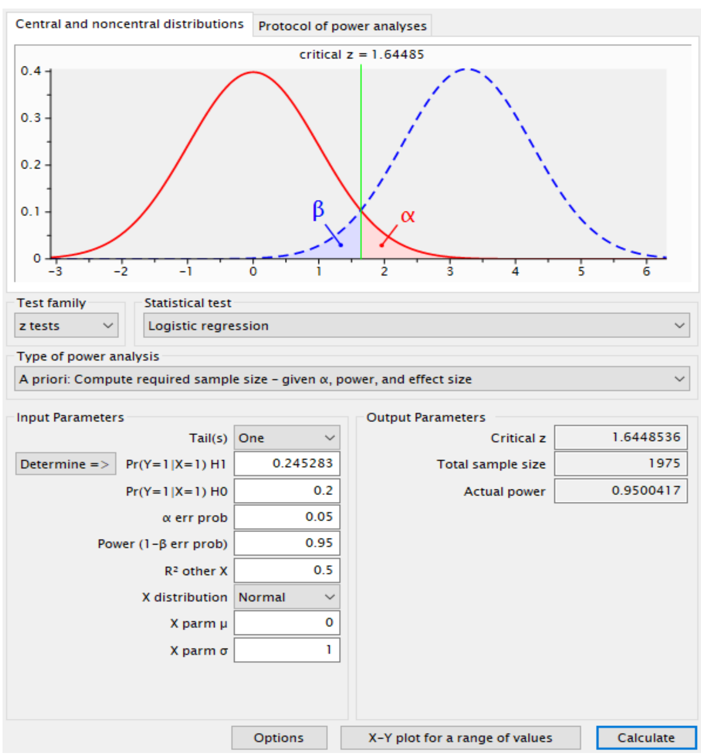
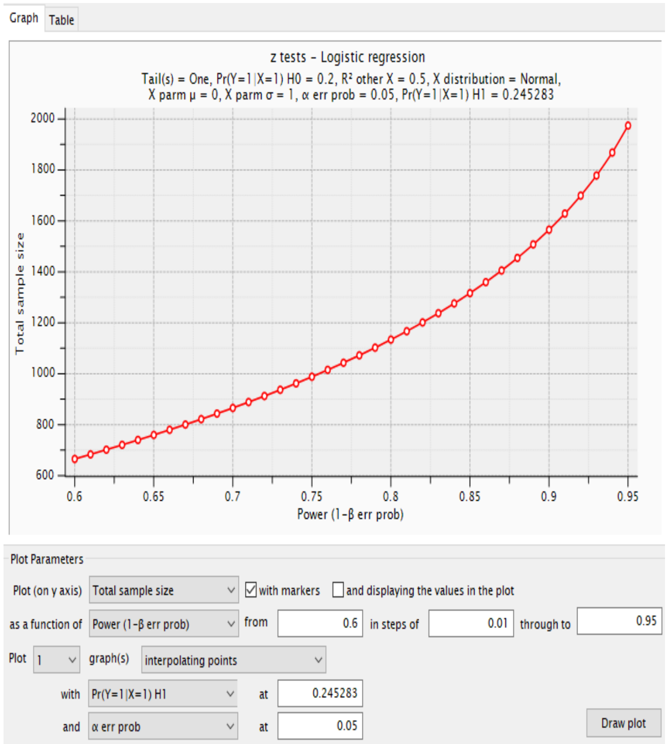
Appendix A: BRFSS Codebook Reports






Graph
Table
z tests - Logistic regression
Tail(s) = One, Pr(Y=1|X=1) H0 = 0.2, R² other X = 0.5, X distribution = Normal,
X parm μ = 0, X parm σ = 1, α err prob = 0.05, Pr(Y=1|X=1) H1 = 0.245283
Total sample size
2000
1800
1600
1400
1200
1000
800
600
0.6
0.65
0.7
0.75
0.8
0.85
0.9
0.95
Power (1-β err prob)
Plot Parameters
Plot (on y axis)
Total sample size
with markers
and displaying the values in the plot
as a function of
Power (1-β err prob)
from
0.6
in steps of
0.01
through to
0.95
Plot
1
graph(s)
interpolating points
with
Pr(Y=1|X=1) H1
at
0.245283
and
α err prob
at
0.05
Draw plot

Appendix B: BRFSS Dataset Variable View

Label: General Health
Section Name: Health Status
Core Section Number: 1
Question Number: 1
Column: 101
Type of Variable: Num
SAS Variable Name: GENHLTH
Question Prologue:
Question: Would you say that in general your health is:

Value	Value Label	Frequency	Percentage	Weighted Percentage
1	Excellent	65,946	15.77	17.35
2	Very good	135,814	32.47	31.39
3	Good	133,631	31.95	32.27
4	Fair	59,725	14.28	14.09
5	Poor	22,105	5.29	4.68
7	Don't know/Not Sure	741	0.18	0.15
9	Refused	280	0.07	0.07
BLANK	Not asked or Missing	26	.	.

Label: How Often Check Blood for Glucose
Section Name: Diabetes
Module Number: 2
Question Number: 2
Column: 281-283
Type of Variable: Num
SAS Variable Name: BLDSUGAR
Question Prologue:
Question: About how often do you check your blood for glucose or sugar? [Include times when checked by a family member or friend, but do NOT include times when checked by a health professional.]

Value	Value Label	Frequency	Percentage	Weighted Percentage
101 - 199	Times per day Notes: 1 _ _ Times per day	14,749	57.21	57.41
201 - 299	Times per week Notes: 2 _ _ Times per week	4,214	16.35	16.95
301 - 399	Times per month Notes: 3 _ _ Times per month	1,748	6.78	6.33
401 - 499	Times per year Notes: 4 _ _ Times per year	1,635	6.34	5.62
777	Don't know/Not sure	557	2.16	2.62
888	Never	2,812	10.91	10.84
999	Refused	65	0.25	0.22
BLANK	Not asked or Missing Notes: Section 06.11, DIABETE4, is coded 2, 3, 4, 7, 9, or Missing	392,488	.	.

Label: Times Checked for Glycosylated Hemoglobin
Section Name: Diabetes
Module Number: 2
Question Number: 5
Column: 289-290
Type of Variable: Num
SAS Variable Name: CHKHEMO3
Question Prologue:
Question: About how many times in the past 12 months has a doctor, nurse, or other health professional checked you for A-one-C?

Value	Value Label	Frequency	Percentage	Weighted Percentage
1 - 76	Number of times [76=76 or more] Notes: _ _ Number of times, 76 = 76 or more	22,648	87.85	85.21
88	None	1,375	5.33	7.09
98	Never heard of "A one C" test	380	1.47	1.83
77	Don't know/Not sure	1,297	5.03	5.49
99	Refused	79	0.31	0.38
BLANK	Not asked or Missing Notes: Section 06.11, DIABETE4, is coded 2, 3, 4, 7, 9, or Missing	392,489	.	.

Label: Imputed race/ethnicity value
Section Name: Weighting Variables
Module Number: 1
Question Number: 12
Column: 1471-1472
Type of Variable: Num
SAS Variable Name: _IMPRACE
Question Prologue:
Question: Imputed race/ethnicity value (This value is the reported race/ethnicity or an imputed race/ethnicity, if the respondent refused to give a race/ethnicity. The value of the imputed race/ethnicity will be the most common race/ethnicity response for that region of the state)

Value	Value Label	Frequency	Percentage	Weighted Percentage
1	White, Non-Hispanic	318,594	76.17	62.26
2	Black, Non-Hispanic	31,735	7.59	11.69
3	Asian, Non-Hispanic	9,296	2.22	5.28
4	American Indian/Alaskan Native, Non-Hispanic	6,697	1.60	1.06
5	Hispanic	37,527	8.97	17.52
6	Other race, Non-Hispanic	14,419	3.45	2.20

Label: Adults with good or better health
Section Name: Calculated Variables
Module Number: 1
Question Number: 1
Column: 1899
Type of Variable: Num
SAS Variable Name: _RFHLTH
Question Prologue:
Question: Adults with good or better health

Value	Value Label	Frequency	Percentage	Weighted Percentage
1	Good or Better Health Notes: GENHLTH = 1 or 2 or 3	335,391	80.19	81.01
2	Fair or Poor Health Notes: GENHLTH = 4 or 5	81,830	19.56	18.76
9	Don't know/Not Sure Or Refused/Missing Notes: GENHLTH = 7 or 9 or Missing	1,047	0.25	0.23

Label: Computed Preferred Race
Section Name: Calculated Race Variables
Module Number: 8
Question Number: 3
Column: 1969-1970
Type of Variable: Num
SAS Variable Name: _PRACE1
Question Prologue:
Question: Preferred race category

Value	Value Label	Frequency	Percentage	Weighted Percentage
1	White Notes: MRACASC1 = 10	335,876	80.31	71.00
2	Black or African American Notes: MRACASC1 = 20	34,392	8.22	12.72
3	American Indian or Alaskan Native Notes: MRACASC1 = 30	8,914	2.13	1.81
4	Asian Notes: MRACASC1 = 40,41,42,43,44,45,46,47	10,251	2.45	5.53
5	Native Hawaiian or other Pacific Islander Notes: MRACASC1 = 50,51,52,53,54	3,670	0.88	0.42
6	Other race Notes: MRACASC1 = 60	13,126	3.14	4.77
7	No preferred race Notes: MRACASC1 >= 100 and ORACE3 = 7 or 9	1,376	0.33	0.30
77	Don't know/Not sure Notes: MRACASC1 = 77	3,848	0.92	1.60
99	Refused Notes: MRACASC1 = 99	6,793	1.62	1.86
BLANK	Missing Notes: MRACASC1 = Missing	22	.	.

Label: Computed Race-Ethnicity grouping
Section Name: Calculated Race Variables
Module Number: 8
Question Number: 7
Column: 1976
Type of Variable: Num
SAS Variable Name: _RACE
Question Prologue:
Question: Race/ethnicity categories

Value	Value Label	Frequency	Percentage	Weighted Percentage
1	White only, non-Hispanic Notes: _HISPANC = 2 and _MRACE1 = 10	310,750	74.30	60.55
2	Black only, non-Hispanic Notes: _HISPANC = 2 and _MRACE1 = 20	31,423	7.51	11.58
3	American Indian or Alaskan Native only, Non-Hispanic Notes: _HISPANC = 2 and _MRACE1 = 33	6,569	1.57	1.04
4	Asian only, non-Hispanic Notes: _HISPANC = 2 and _MRACE1 = 40,41,42,43,44,45,46,47	9,179	2.19	5.23
5	Native Hawaiian or other Pacific Islander only, Non-Hispanic Notes: _HISPANC = 2 and _MRACE1 = 50,51,52,53,54	2,379	0.57	0.21
6	Other race only, non-Hispanic Notes: _HISPANC = 2 and _MRACE1 = 60	3,219	0.77	0.59
7	Multiracial, non-Hispanic Notes: _HISPANC = 2 and _MRACE1 = 77	8,404	2.01	1.30
8	Hispanic Notes: _HISPANC = 1	37,410	8.94	17.38
9	Don't know/Not sure/Refused Notes: _HISPANC = 7 or 9 or _MRACE1 = 77 or 99 and _HISPANC = 2	8,932	2.14	2.11
BLANK	Missing Notes: _HISPANC = Missing or _MRACE1 = Missing	3	.	.

Label: Calculated sex variable
Section Name: Calculated Variables
Module Number: 8
Question Number: 11
Column: 1980
Type of Variable: Num
SAS Variable Name: _SEX
Question Prologue:
Question: Calculated sex variable

Value	Value Label	Frequency	Percentage	Weighted Percentage
1	Male Notes: BIRTHSEX=1 or BIRTHSEX notin (1,2) and SEXVAR=1	189,835	45.39	48.72
2	Female Notes: BIRTHSEX=2 or BIRTHSEX notin (1,2) and SEXVAR=2	228,433	54.61	51.28

Label: Education Level
Section Name: Demographics
Core Section Number: 8
Question Number: 6
Column: 174
Type of Variable: Num
SAS Variable Name: EDUCA
Question Prologue:
Question: What is the highest grade or year of school you completed?

Value	Value Label	Frequency	Percentage	Weighted Percentage
1	Never attended school or only kindergarten	619	0.15	0.30
2	Grades 1 through 8 (Elementary)	9,940	2.38	4.54
3	Grades 9 through 11 (Some high school)	19,506	4.66	8.04
4	Grade 12 or GED (High school graduate)	111,890	26.75	27.68
5	College 1 year to 3 years (Some college or technical school)	116,591	27.88	30.71
6	College 4 years or more (College graduate)	157,887	37.75	28.26
9	Refused	1,809	0.43	0.47
BLANK	Not asked or Missing	26	.	.

Label: Income Level
Section Name: Demographics
Core Section Number: 8
Question Number: 16
Column: 191-192
Type of Variable: Num
SAS Variable Name: INCOME2
Question Prologue:
Question: Is your annual household income from all sources: (If respondent refuses at any income level, code ´Refused.´)

Value	Value Label	Frequency	Percentage	Weighted Percentage
1	Less than $10,000 Notes: If "no," code 02	15,860	3.86	4.59
2	Less than $15,000 ($10,000 to less than $15,000) Notes: If "no," code 03; if "yes," ask 01	16,122	3.92	3.77
3	Less than $20,000 ($15,000 to less than $20,000) Notes: If "no," code 04; if "yes," ask 02	23,391	5.69	5.74
4	Less than $25,000 ($20,000 to less than $25,000) Notes: If "no," ask 05; if "yes," ask 03	30,001	7.29	7.29
5	Less than $35,000 ($25,000 to less than $35,000) Notes: If "no," ask 06	34,496	8.39	8.11
6	Less than $50,000 ($35,000 to less than $50,000) Notes: If "no," ask 07	46,572	11.32	10.49
7	Less than $75,000 ($50,000 to less than $75,000) Notes: If "no," code 08	54,252	13.19	12.31
8	$75,000 or more	117,793	28.63	30.30
77	Don't know/Not sure	32,654	7.94	8.46
99	Refused	40,246	9.78	8.94
BLANK	Not asked or Missing	6,881	.	.

Label: Are you male or female?
Section Name: Sex at Birth
Module Number: 28
Question Number: 1
Column: 620
Type of Variable: Num
SAS Variable Name: BIRTHSEX
Question Prologue:
Question: What was your sex at birth? Was it male or female?

Value	Value Label	Frequency	Percentage	Weighted Percentage
1	Male	30,527	46.95	47.80
2	Female	34,227	52.64	51.66
7	Don't know/Not Sure	99	0.15	0.29
9	Refused	165	0.25	0.25
BLANK	Not asked or Missing	353,250	.	.

Label: Reported age in five-year age categories calculated variable
Section Name: Calculated Variables
Module Number: 8
Question Number: 12
Column: 1981-1982
Type of Variable: Num
SAS Variable Name: _AGEG5YR
Question Prologue:
Question: Fourteen-level age category

Value	Value Label	Frequency	Percentage	Weighted Percentage
1	Age 18 to 24 Notes: 18 <= AGE <= 24	25,098	6.00	12.21
2	Age 25 to 29 Notes: 25 <= AGE <= 29	20,817	4.98	8.03
3	Age 30 to 34 Notes: 30 <= AGE <= 34	23,058	5.51	9.38
4	Age 35 to 39 Notes: 35 <= AGE <= 39	24,724	5.91	8.02
5	Age 40 to 44 Notes: 40 <= AGE <= 44	24,258	5.80	7.99
6	Age 45 to 49 Notes: 45 <= AGE <= 49	26,075	6.23	6.87
7	Age 50 to 54 Notes: 50 <= AGE <= 54	31,768	7.60	8.40
8	Age 55 to 59 Notes: 55 <= AGE <= 59	38,902	9.30	7.87
9	Age 60 to 64 Notes: 60 <= AGE <= 64	44,456	10.63	8.52
10	Age 65 to 69 Notes: 65 <= AGE <= 69	45,206	10.81	6.57
11	Age 70 to 74 Notes: 70 <= AGE <= 74	41,535	9.93	5.91
12	Age 75 to 79 Notes: 75 <= AGE <= 79	29,767	7.12	4.11
13	Age 80 or older Notes: 80 <= AGE <= 99	35,916	8.59	4.58
14	Don't know/Refused/Missing Notes: 7 <= AGE <= 9	6,688	1.60	1.55