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Language Acculturation Effect on Diabetes Prevalence and Self-Care Skills in Puerto Ricans

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This is to certify that the doctoral dissertation by

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Walden University
2020

Abstract

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BA, Universidad Ricard Palma, 2010

BS, Universidad Peruana Cayetano Heredia, 1993

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Diabetes, a silent, chronic disease that involves demanding long-term self-care skills, affects adult Puerto Ricans disproportionately. Based on the health belief model, a theory that predicts health behavior, and the theory of language barriers, which predicts the effects of language on beliefs and behavior, this quantitative nonexperimental study analyzed the relationship of the preference of Puerto Ricans in Boston to use and speak Spanish (language acculturation) to diabetes prevalence and 4 diabetes self-care skills (healthy eating, being active, taking medication, and healthy coping). Data on 1,506 initial participants in the Boston Puerto Rican Health Study were used from 3 study stages (baseline, 2-year, and 5-year follow-up). The data were analyzed using logistic regression. The study findings indicated that diabetes prevalence was high and steady across all study stages (50%), and it was associated with sociological factors (length of stay in the United States) and anthropometric measures (waist circumference and body mass index). Language acculturation had a statistically significant association with diabetes prevalence (decrease) and the 4 self-care skills variably across the 3 study stages, even after adjusting for confounders. These findings indicate that language acculturation permeates the perceptions, beliefs, and decision-making processes of Puerto Ricans. Further research is necessary to overcome the understudied nature of Puerto Ricans and the consequences of their limited English proficiency when managing diabetes. The study's implications for social change involve the inclusion of language acculturation in health care and public health initiatives to prevent, manage, and reduce the long-term consequences and rising management costs of diabetes.

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Dedication

I want to dedicate this proposal to my wife, my two sons, my parents, and my siblings. Thank you for understanding my desire to learn and contribute with new knowledge and for providing me with the support, love, and patience that encourage me to pursue my best self and move forward always. This dissertation is also dedicated to those of us who, at some point in life, have experienced the consequences of language barriers in a complex professional environment such as health care.

Acknowledgments

This dissertation study was made possible by the unmeasurable guidance, patience, expertise, and words of encouragement of my chair, Dr. Angela Prehn. I also acknowledge the immense value of the expertise and guidance that my dissertation committee members, especially Dr. Leslie Elliott, have provided to this study. Additionally, Dr. Htway Zin provided much-needed guidance in the statistical analysis process, simplifying a complex process into a concrete application. Thank you also to Dr. W. Sumner Davis, the University Research Reviewer, for your expertise and guidance.

Last, I acknowledge the linguistic, social, cultural, and public health realities that opened my eyes when choosing to live and assimilate to the language and culture of the United States as an immigrant and professional medical interpreter. This resulted in the discovery of the ongoing desire for learning and improving our public health knowledge to improve our reality.

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Chapter 1: Introduction to the Study

Introduction

Diabetes, a silent and progressive long-term (chronic) disease, is characterized by elevated levels of glucose (sugar) in the blood (hyperglycemia) that are poorly controlled by insulin, the pancreatic hormone that is expected to regulate glucose concentration in blood. The classification of diabetes as a disease usually includes three types: *type 1 diabetes* (T1D), characterized by an autoimmune etiology; *type 2 diabetes* (T2D), which is often idiopathic with insulin resistance and insulin deficiency and is frequently associated with lifestyle, obesity, and the metabolic syndrome; and *gestational diabetes* (GD), a temporary type of hyperglycemia that usually resolves postpartum (Thomas & Philipson, 2015).

The complexity of diabetes is observed in the pathophysiology of the disease, separating insulin dependent (type 1) and insulin resistant (type 2). The complexity also includes the discussion over its current and future classification and diagnosis; the long-term need of skills and activities that should ensure proper management of the disease, and the intricate, convoluted, and often ignored long-term effects of lifestyle and nutritional choices before and after the diagnosis of diabetes (Ahlqvist et al., 2018; American Association of Diabetes Educators [AADE], 2017; American Diabetes Association [ADA], 2019a; Anders & Schroeter, 2015; Kandimalla, Thirumala, & Reddy, 2017; Thomas & Philipson, 2015; Zaccardi, Webb, Yates, & Davies, 2016).

The importance of diabetes as a disease lies in its silent onset and long-term progression, with symptoms usually only noticeable when complications are already present (Thomas & Philipson, 2015). These complications are numerous and systemic, and they can have severe long-term consequences at microvascular and macrovascular levels, such as neuropathy, retinopathy, kidney failure, and cardiovascular disease (Domingueti et al., 2016; Forbes & Fotheringham, 2017; Zheng, Ley, & Hu, 2018).

In 2014, the World Health Organization (WHO, 2016) estimated that there were approximately 422 million people with diabetes worldwide. In the United States, diabetes affects 30.3 million people of all races, and 90% to 95% of diabetes cases are type 2 diabetes (T2D; Centers for Disease Control and Prevention [CDC], 2017).

In the United States, the CDC (2018a) reported that 30.2 million adults (18 years or older), representing 9.4% of the total U.S. population and 12.2% of the adult U.S. population, had diabetes in 2015. Of those, 7.2 million had diabetes but were either unaware of it or did not report it (CDC, 2018a). The CDC has reported diagnosed diabetes by race and ethnic group, presenting data for Whites, African Americans, and Hispanics since 1997 and including data for Asians in 1999. Since 1997, historical trends of diagnosed diabetes have indicated that African Americans and Hispanics are the two subpopulations with the highest diagnosed diabetes percentages in the United States (CDC, n.d.-a). In 2017, the rate of diagnosed diabetes in Hispanics reached 12.5%, the highest age-adjusted national diagnosed diabetes for adults (18 years or more), compared to a national average of 8.5% (CDC), as seen in Figure 1.

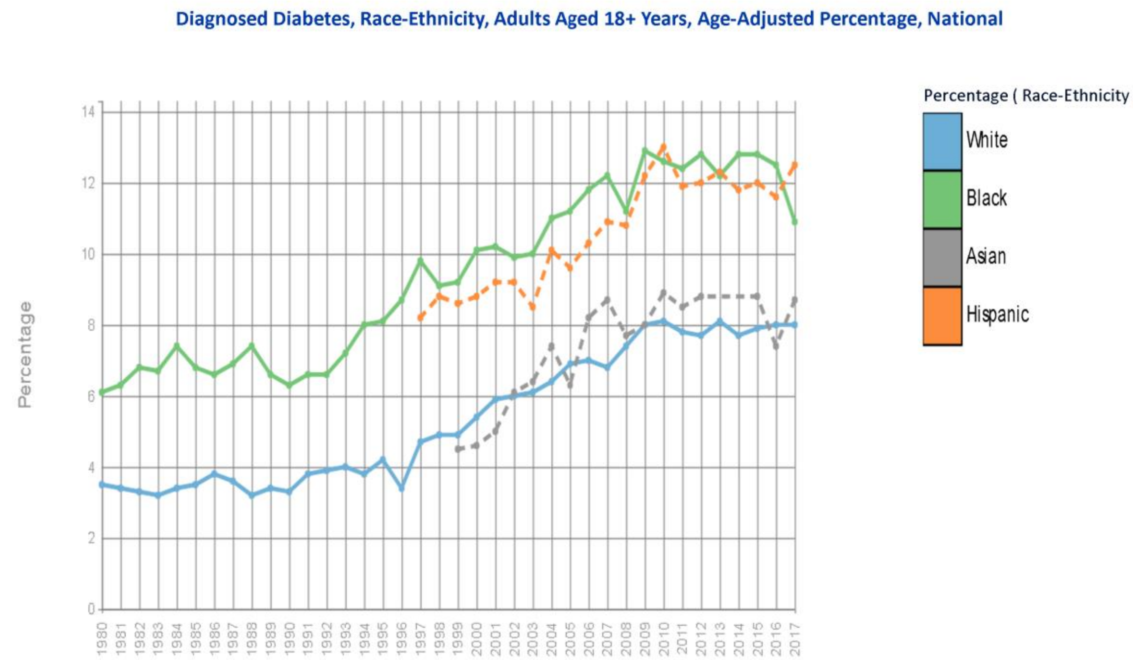

Figure 1. Diagnosed diabetes, race-ethnicity, adults aged 18+ years, age-adjusted percentage, national. From "Diagnosed Diabetes," by Centers for Disease Control and Prevention, n.d. (https://gis.cdc.gov/grasp/diabetes/DiabetesAtlas.html#). In the public domain.

A more recent CDC report indicates that U.S. adults have a 40% chance of developing T2D. However, adult Hispanics/Latinos (H/L) have more than a 50% chance of developing T2D (CDC, 2019c).

A more in-depth analysis of Hispanic/Latino populations in the United States with diabetes is warranted to implement public health interventions that foster prevention, patient self-care, and disease management skills, in addition to addressing the long-term consequences of diabetes.

In this dissertation study, I focused on adult Puerto Ricans with diabetes for several reasons: the demographic importance of Puerto Ricans, the prevalence of diabetes among adult Puerto Ricans, the lack of previous research on disease management skills among adult Boston Puerto Ricans with diabetes, and the use of Spanish as as the primary spoken language within this population.

From a demographic perspective, Puerto Ricans are the second-largest subpopulation of Hispanics/Latinos in the continental United States, following Mexicans, in a proportion of 1:7 (seven Mexicans per Puerto Rican) in the continental United States (U.S. Census Bureau, 2018). From a disease perspective, Puerto Ricans consistently showed the highest age-adjusted prevalence of diagnosed diabetes (12.7%) among adults between 1995 and 2012, as well as the second-highest prevalence of diabetes (14.5%) between 2011 and 2015 (CDC, 2012; Cowie, Casagrande, & Geiss, 2018). Puerto Ricans are Spanish speakers who are deemed U.S. citizens at birth. Use of the Spanish language and limited English proficiency may impact Puerto Ricans' access to care due to language barriers, which may hamper the development of self-care and diabetes management skills, leading to poorer health outcomes (Aguayo-Mazzucato et al., 2019; Ritter, Lorig, & Laurent, 2016).

Background

Diabetes is a disease that does not affect populations equally throughout the United States. Ethnic minority populations are disproportionately affected by diabetes. In 2016, following a multiyear trend, the highest diabetes prevalence rates were reported for American Indians/Alaska Natives (15.1%), non-Hispanic Blacks (12.7%), and Hispanics (12.1%; CDC, 2018a).

The H/L population tends to be younger, to have less educational attainment, and to have lower physical activity levels than the overall U.S. population, showing higher diabetes prevalence rates and a disproportionate burden from healthcare disparities (Lai, Alfaifi, & Althemery, 2017). The Agency for Healthcare Research and Quality (AHRQ) reported this disproportion in healthcare disparities in H/L populations in multiple annual reports, with a consistent tendency showing more than 30% of health care quality measures are worse for H/L populations compared to Whites (AHRQ, 2016, 2017, 2018, 2019).

A closer analysis of the diabetes prevalence rates in H/L populations living in the United States reveals a prevalence gradient. Schneiderman et al. (2014) showed this gradient with the lowest diabetes prevalence rate among South Americans (10.2%), with prevalence rate increasing for northern populations such as Central Americans (17.7%) and reaching the highest level in Dominicans (18.1%), Puerto Ricans (18.1%), and Mexicans (18.3%). This geographic gradient shows the highest diabetes prevalence rates when H/L subpopulations are geographically closer to the continental United States.

Current and past diabetes research has largely ignored this gradient. Most diabetes research has focused primarily on the H/L population as one group, without consideration that the three highest prevalence rates are present in Mexicans, Puerto Ricans, and Dominicans living in the United States (Lopez, 2014). Most diabetes research studies selectively address diabetes in Mexicans and Mexican Americans (Brown, 1999; Caban, 2008; de Alba Garcia, 2007; Thompson, 2007). The scanty research evidence on H/L subpopulations also contrasts with the fact that Puerto Ricans have had the highest age-adjusted prevalence of diagnosed diabetes among adults from Hispanic populations since 1995 but appear to be second in diabetes prevalence rate after Mexicans (18.1% vs.

18.35, respectively; CDC, 2012). Therefore, more diabetes research focused on Puerto Rican populations is needed to shed light on the nuances in data reported by Hispanic country of origin.

A common practice in H/L populations is the preferred use of Spanish as the primary spoken language. This practice is of great importance when considering individuals with limited ability to understand, speak, read, or write in English, also called *limited English proficient* (LEP) individuals (LEP.gov, 2018). The H/L populations living in the United States that are LEP, including Puerto Ricans, appear to be at a public health disadvantage compared to English speakers. This disadvantage is visible with H/L populations showing 133% higher diabetes prevalence rates and 51% higher death rates from diabetes compared to Whites (CDC, 2015a). This phenomenon is not new and has been reported for over a decade (Flores, 2006; Flores & Tomany-Korman, 2008). Njeru et al. (2017) considered that limited English proficiency is a risk factor for health disparities. As such, it is associated with limitations in health care, including suboptimal patient-provider interactions, as well as diabetes self-care with poor glycemic control, factors that can impact an individual’s long-term success in managing diabetes (Njeru et al., 2017). Martinez (2010) reported that severe consequences ranging from longer time to get health care and even death are far too common results of the language barrier that LEP individuals face when accessing care in the continental United States (Martinez, 2010).

Using the English language more frequently and proficiently is usually associated with higher levels of social and linguistic integration, as part of a process defined as acculturation (Abraído-Lanza, Echevarría, & Flórez, 2016; Fox, Thayer, & Wadhwa, 2017). The initial anthropological definition of acculturation involved the cultural and linguistic changes (language acculturation) that occur within the interaction between two groups that come into contact (Fox et al., 2017). The concept has since evolved and is broadly understood as the adaptation process through which individuals who live in a new environment adopt the norms, values, and practices of the new environment (i.e., society; Abraído-Lanza et al., 2016).

Acculturation is a complex process that requires further studies to understand its effects on foreign-born immigrants. For example, the interaction between acculturation and health behaviors is yet to be clearly understood. Research studies in this area should address the effects of spoken language and language acculturation in the acculturation process because language is usually taken as a proxy during unidimensional measures of acculturation in a country where English is predominantly used (Schwartz, 2017). The preference for the spoken language may act as a factor, perhaps indirect, that impacts the complex relationship between language, culture, the formation of interethnic networks, and health behavior (Tegegne, 2018). This is due to the association with the use of Spanish as a preferred language, and the difficulties that LEP patients face in and out of the U.S. health care system (Avilés-Santa, 2017; Flores, 2014; Oza-Frank, Chan, Liu, Burke, & Kanaya, 2013). Similarly, there is a lack of specific information about the association between the preferred language spoken, diabetes prevalence, and self-care skills in H/L populations, particularly in Puerto Rican populations (Lawrence et al., 2009). Another critical factor in this population may be the length of stay or residence in the mainland United States.

Using a multifactorial approach considering important aspects of the interaction between people with LEP and their disease onset and management processes is warranted. Those aspects entail linguistic, health behavior, and health communication approaches. From a *linguistic* perspective, the challenges in the preferred use of language come on both fronts of communication, spoken and written. There is the heterogeneity of spoken Spanish in the continental United States, a consequence of the growing demographic penetration of the past decades, primarily represented by Mexicans, Puerto Ricans, and Cubans (Dumitrescu, 2013). This demographic growth makes Spanish speakers in the United States the second largest population of Spanish speakers in the world (Instituto Cervantes, 2017).

From a *health behavior* approach, the association between language and health behavior goes beyond the lack of linguistic proficiency and effective communication to and from LEP patient populations. The language–health behavior association also affects the communication between healthcare providers and Spanish-speaking patients (Flores, 2006; Flores & Tomany-Korman, 2008). This bidirectional communication, or language concordance, is of great importance in the provision of health care services to the H/L population, which is the largest minority group in the United States (17.8%; U.S. Census Bureau, 2017b). With demographic growth of 2.0% per year, the H/L population is second only to Asians (growing at 3.0% per year) as the fastest growing ethnic population in the United States (U.S. Census Bureau, 2017b). In 2018, the U.S. Census

Bureau made two critical projections involving H/L populations. First, it predicted that the H/L population will grow to almost double its current size, from 57.4 million to 111.0 million, by 2060. Second, by the year 2030, net international migration may become the largest driver of population growth (Vespa, Armstrong, & Medina, 2018). Both population growth projections make it even more important to pinpoint the major factors impacting the health care and disease management of H/L populations for the foreseeable future.

The disease management process of diabetes is the result of a combination of linguistic and health behavior factors when language concordance and the development of diabetes management skills are considered. Patients seem to get better health outcomes when they receive treatment from healthcare providers who speak their language (i.e., when there is language concordance). In a 2017 study, the authors reported a significant improvement in glycemic and low-density lipoprotein (LDL) control in LEP patients seen by language-concordant physicians or seen with trained medical interpreters (Parker et al., 2017). In a 2019 systematic review study, it was found that in the majority of studies analyzed (25 out of 33 studies, or 76%), at least one outcome improved in patients receiving language-concordant care and that 9% of the studies (3 out of 33) identified a worse outcome in patients receiving language-concordant care (Diamond, Izquierdo, Canfield, Matsoukas, & Gany, 2019). In contrast, the authors of a 2019 meta-analysis study concluded that although the ethnic-concordance and language-concordance factors seemed to have positive effects on Spanish-speaking patients' behavior (16.6%), provider behaviors (46.2%), interpersonal processes of care (51.6%), and clinical outcomes

(20.6%), the studies had methodological limitations due to the studies' inconsistencies in defining, classifying, and assessing language concordance (Hsueh, Hirsh, Maupomé, & Stewart, 2019). A significant difference between the meta-analysis and the systematic review is that 9% of the outcomes were worse in the patients receiving language-concordant care in the systematic review, whereas virtually no deleterious effect of language-concordant care was found in the meta-analysis. In both cases, the lack of definition and assessment of the language proficiency of providers was identified as an important limitation.

From a *health communication* perspective, the presence of a potential association between diabetes (chronic disease), diabetes self-care behaviors (healthy eating, being active, monitoring, and taking medication), and the use of Spanish as the preferred language (language acculturation) by Puerto Ricans is important to understand. This dissertation study focused on the potential effect of language acculturation (favoring the use of Spanish or English over the other language) on the prevalence and management of T2D in patients of Puerto Rican origin in the Boston metropolitan area. As a major H/L subpopulation in the continental United States, Puerto Ricans are largely underrepresented in the diabetes scientific literature, despite the high diabetes prevalence and generally poorer health outcomes in this population relative to other English and Spanish-speaking subpopulations in the United States.

Problem Statement

The abundance of diabetes studies concerning H/L populations address Mexican American populations, or Hispanic populations primarily as a cluster. This clustering leaves gaps of knowledge concerning Puerto Ricans, who show a tendency to travel to the continental United States to seek better health care and a higher standard of living without the immigration-related restrictions and difficulties that other Spanish-speaking populations face. This travel pattern is called *circular migration*, with patterns of stays that average 2 years or less (Aranda & Rivera, 2016; Torres & Wallace, 2013). The effects of the circular migration of Puerto Ricans are understudied. There is a lack of comprehensive epidemiological studies in the island of Puerto Rico as a point of reference. For example, a few reports have identified mixed disease and mortality rates of Puerto Ricans in Puerto Rico and Puerto Ricans in the continental United States; for example, age-adjusted diabetes mortality rates are more than twice as high in the United States (63.8) as in Puerto Rico (31.2; Colón-Ramos et al., 2017).

The economic recession and slow reconstruction after Hurricane Maria may have accelerated the flight of Puerto Ricans to the U.S. mainland (Cohn, Patten, & Lopez, 2014; Mattei et al., 2017). In a 2018 report that included data on school enrollment and data from the Federal Emergency Management Agency (FEMA), it was indicated that Massachusetts, Connecticut, and New York were three states that exceeded projections for Puerto Rican migration after Hurricane Maria (Hinojosa, Román, & Meléndez, 2018). A gap in the research literature exists because no regional or nationwide study has accounted for Puerto Rican families and their T2D prevalence and self-care behaviors.

The research literature largely ignores the essential language differences and the challenges that H/L populations experience. The diminished perception or understanding of important factors such as perceived susceptibility and severity of disease and self-efficacy to manage a demanding chronic disease such as diabetes may explain the differences in mortality rates of Puerto Ricans in the island and in the continental United States. Multiple potential associations among patient and healthcare provider behaviors and clinical outcomes can be assessed, as indicated before, with a multifactorial approach combining language and the overall acculturation process (including language acculturation), health behavior, acculturation, and health communication perspectives.

The effect of language acculturation on the management of T2D provided the rationale for the entire dissertation and related to the research gap in this area pertaining to diabetes self-care. This dissertation sheds light on how language acculturation may contribute to the prevalence rate of diabetes in adult Puerto Ricans, as well as the undermining of the disease management process in Puerto Ricans with T2D whose preference to use the Spanish language is discordant with the systemic use of English as the primary language in the United States. This dissertation study may also provide the contextual basis for the development of resources to address such disparities.

Purpose

The purpose of this study was to generate knowledge of the indirect effect that the use of Spanish as a preferred language has on Puerto Ricans in relation to both the occurrence and management of T2D. This study focused on the relation between the preferred use of the Spanish language (language acculturation), T2D prevalence, and self-care skills for T2D (healthy eating, being active, monitoring, and taking medication among those diagnosed) in adult Puerto Ricans living in the continental United States

(Boston metropolitan area). The study involved the use of a quantitative methodology with data from a longitudinal regional survey.

Research Questions

The descriptive research question was as follows:

RQ1: What is the proportion of the adult population sample of Puerto Ricans living in the Boston metropolitan area that uses Spanish as their primary language?

The analytical research questions were as follows:

RQ2: Which factors contribute to diabetes prevalence in the adult population sample of Puerto Ricans living in the Boston metropolitan area that uses Spanish as their primary language?

RQ3: What is the relationship between language acculturation and diabetes prevalence in the adult population sample of Puerto Ricans living in the Boston metropolitan area, after adjusting for potential confounders (age/gender/educational attainment/length of stay in the United States)?

RQ4: What is the relationship between language acculturation and diabetes self-care skills (healthy eating, being active, taking medication, and healthy coping) in Puerto Ricans living in the Boston metropolitan area, after adjusting for potential confounders (age/gender/educational attainment/length of stay in the United States)?

Null Hypothesis 1 (H01): The preferred use of Spanish (language acculturation) in Puerto Ricans in the Boston metropolitan area has no relationship with diabetes prevalence rate.

Alternative Hypothesis 1 (HA1): The preferred use of Spanish (language acculturation) in Puerto Ricans in the Boston metropolitan area has a relationship with diabetes prevalence rate.

Null Hypothesis 2 (H02): The preferred use of Spanish (language acculturation) in Puerto Ricans in the Boston metropolitan area has no relationship with diabetes self-care behaviors.

Alternative Hypothesis 2 (HA2): The preferred use of Spanish (language acculturation) in Puerto Ricans in Boston has a relationship with diabetes self-care behaviors.

Theoretical Framework

The theoretical basis for this study included the health belief model (HBM) and the theory of language barriers (TLB), a new and specific theoretical proposal (Hochbaum, 1958; Rosenstock, 1960; Martinez, 2010). The HBM is a theory that addresses health behavior at the individual level. It was initially developed in the 1950s by social psychologists (Hochbaum, 1958; Rosenstock, 1960), emphasizing the encouraging and discouraging elements affecting health behaviors (National Cancer Institute [NCI], 2005). The original theory involved four perception elements: perceived susceptibility, perceived severity, perceived benefits, and perceived barriers (Champion & Skinner, 2008). However, two additional constructs were added over time: cues to action and self-efficacy (Glanz, Rimer, & Viswanath, 2015). Although the six constructs may affect the disease outcome, it is the construct of self-efficacy that may have a direct connection with the outcome of T2D. The outcome improves when self-efficacy is addressed in physical activity and disease management interventions (Ha, Hu, & Petrini, 2014; Olson & McAuley, 2015).

Patients with diabetes tend to have lower self-efficacy managinf the disease than patients without diabetes, which may be in part due to the demanding knowledge and effectiveness of daily management of T2D and its association with health literacy and language (Kamimura et al., 2014). A 2018 nursing study proved the negative association between self-efficacy and a non-English spoken language, where Spanish speakers had less knowledge of the disease and perceived diabetes as less severe than English speakers (Hayden, 2018). Knowledge and perception of disease severity are HBM constructs (perceived severity and self-efficacy), and their predictability may explain why Spanish-speaking diabetes patients have higher diabetes prevalence rates, poor disease management outcomes with hemoglobin A1c, and more diabetes-related complications (Avilés-Santa et al., 2016; CDC, 2018a).

The HBM may be successfully applied to behaviors that involve health concerns or risky behaviors, such as sexual behavior. If people's behavior contributes to the emergence of chronic diseases, especially with sedentary lifestyles and poor nutritional habits (Cecchini et al., 2010), then their behavior can be considered a risk that is prone to change under the appropriate conditions. Therefore, the overwhelming incidence of chronic diseases worldwide provides plenty of opportunities to address major causes that involve health inequalities, people’s behaviors, and socioecological factors (Coreil, 2010).

Multiple foreign studies have indicated that the design and implementation of health education and health promotion interventions using HBM constructs have proven effectiveness in preventing diabetes (Khiyali, Manoochri, Babaei Heydarabadi, & Mobasheri, 2017). In H/L populations, application of the HBM has proven successful in cervical cancer, oral health, obesity reduction, and diabetes interventions (Burner, Menchine, Kubicek, Robles, & Arora, 2014; Keane & Francis, 2018; Romano & Scott, 2014; Scarinci, Bandura, Hidalgo, & Cherrington, 2012; White, Osborn, Gebretsadik, Kripalani, & Rothman, 2013; Wilson, Mulvahill, & Tiwari, 2017). The international nature of this research may help to explain the complexities of Puerto Ricans’ circular migration between the United States and the island of Puerto Rico. Puerto Rican patients with prediabetes or diagnosed diabetes may benefit from HBM-based interventions by understanding their perceived susceptibility and severity of T2D better while diffusing the barriers and raising the importance of educational materials and behavioral change strategies to develop and measure self-efficacy as an ongoing goal.

Those developing HBM-based educational materials and behavioral change strategies that involve health communication should consider language as a central factor during design and implementation processes. Language should play a more prominent role to account for the heterogeneity among Latino populations in the United States. Directed materials may respond more specifically to individuals’ unique language and cultural needs to encourage cues to action that may decrease the risk generated by poor self-care and feeding behaviors.

The TLB is a theory that applies the psycholinguistic nature of language to the language barriers experienced by people living in an environment where their primary language (Spanish) is discordant with the most used language (English). Although the TLB is a theory that focuses on perception and relationships rather than outcomes, it provides a language-barrier approach to analyze health behaviors governed by the beliefs and perceptions of Spanish-speaking, LEP Puerto Ricans. Martinez (2010) described language barriers as comprehensive factors that affect people beyond the communication aspect, interfering with the self-identity of LEP individuals. In the case of Puerto Ricans, their political uniqueness makes them great candidates for an analysis of the effects of U.S. citizenship status at birth and circular migration from epidemiological and health communication perspectives.

This sociolinguistic approach may help to explain the complexities that Puerto Ricans face while living in the continental United States. These complexities are different from those experienced by other H/L populations. The similarities between the HBM's constructs (perceived barriers, perceived susceptibility, perceived threat, perceived benefits, cues to action, and self-efficacy) and the TLB's dimensions of language barriers (barriers of interaction, barriers that ensure that health information is unevenly distributed, barriers of acceptance, and barriers of performance) allow for a synergistic analysis of both theories' constructs.

Nature of the Study

This dissertation study used a quantitative approach to analyze the potential correlation between spoken language, the prevalence of diabetes, and self-care behaviors of diabetes with statistical analyses of a secondary dataset obtained from adult Puerto Ricans in the Boston metropolitan area between 2009 and 2014. The Boston Puerto Rican Health Study (BPRHS) was the source of the data set to conduct the statistical analysis (Tucker et al., 2010). The BPRHS was a longitudinal cohort study where 1,500 Puerto Ricans between 45 and 75 years of age were recruited in Boston to examine psychological, social, metabolic, and genetic factors related to health outcomes (Tucker et al., 2010). The objective of the secondary dataset analysis was to compare the association between Spanish as the primary spoken language and both the prevalence of T2D and self-care behavior in Puerto Ricans with T2D living in the mainland United States.

Definitions

Diabetes: Refers to diabetes mellitus, including T2D, a type of diabetes caused by progressive loss of insulin secretion and insulin resistance and influenced by environmental and lifestyle decisions. In the United States, 90% to 95% of diabetes cases are T2D. In this dissertation study, the use of the term *diabetes* does not include T1D, which is an autoimmune disorder (ADA, 2018, 2019).

Hispanic/Latino (H/L): Refers to people born on the American continent south of the United States, whose preferred language is usually Spanish. This definition does not include racial origin (Comas-Díaz, 2001; García, 2013).

Self-care/self-management: Used interchangeably throughout this dissertation study. These terms refer to the skills, actions, or behaviors needed to manage diabetes. Four self-care skills were selected: healthy eating, being active, taking medication, and healthy coping.

The independent (predicting) variables in the dissertation study included spoken language, language acculturation (see Appendix A), length of stay in the United States, and acculturation (psychological acculturation scale, see Appendix B). The dependent (outcome) variables included diabetes prevalence and four self-care behaviors: healthy eating, being active, taking medication, and healthy coping. The AADE (2017) described seven self-care behaviors, out of which the following four self-care skills were used in this dissertation study.

Healthy eating: “Having diabetes does not mean you have to give up your favorite foods or stop eating in restaurants. In fact, there is nothing you can’t eat. But you need to know that the foods you eat affect your blood sugar” (AADE, 2017).

Being active: “Being active is not just about losing weight. It has many health benefits like lowering cholesterol, improving blood pressure, lowering stress and anxiety, and improving your mood. If you have diabetes, physical activity can also help keep your blood sugar levels to normal and help you keep your diabetes in control” (AADE, 2017).

Taking medication: “There are several types of medications that are often recommended for people with diabetes. Insulin, pills that lower your blood sugar, aspirin, blood pressure medication, cholesterol-lowering medication, or a number of others may work together to lower your blood sugar levels, reduce your risk of complications and help you feel better” (AADE, 2017).

Healthy coping: “Diabetes can affect you physically and emotionally. It’s natural to have mixed feelings about your diabetes management and experience highs and lows. The important thing is to recognize these emotions as normal but take steps to reduce the negative impact they can have on your self-care” (AADE, 2017).

Assumptions

The dataset from the BPRHS reports diabetes prevalence as a unit, and it does not discriminate between T1D and T2D. For this dissertation study, the data on diabetes prevalence are assumed to pertain to T2D. Population studies support this assumption, and U.S. government reports that indicate that 90% to 95% of diabetes cases in the United States are T2D (CDC, 2018a; Xu et al., 2018).

The criterion to deem the BPRHS interviewers as bilingual was not specified, and it is assumed that the bilingual skills of the interviewers did not influence or interfere with the participants’ answers. The BPRHS participants’ self-identification as Puerto Rican is assumed to fit either birth on the island of Puerto Rico, or birth in the United States to Puerto Rican parents. The self-identification aspect in Puerto Ricans is complex, as many Puerto Ricans self-report as Whites in the U.S. Census, rather than as having two or more races, furthering the policy-making challenge to address health inequalities (Allen, 2015).

Scope and Delimitations

The scope of this dissertation study included a population of adult Puerto Ricans from the Boston metropolitan area. This population was included in the BPRHS following participants' Puerto Rican self-identification with an age range between 45 and 75 years. The relevance of this population refers to the fact that most diabetes cases (type 2) usually have adult onset.

The BPRHS exclusion criteria included the following characteristics: the presence of serious illness, moving away during the study period, homelessness status, hostile participant, and others (Tucker et al., 2010). The exclusion criteria restricted the generalizability of the results that were obtained, in that the study did not include participants with diabetes with severe comorbidities. At the same time, the study excluded potential confounders such as participants leaving the study or unreliable answers.

Limitations

The BPRHS data were obtained using previously validated psychological and clinical protocols. The threats to internal validity were reduced because those psychological and clinical protocols had been previously validated. The validity and significance of the BPRHS dataset have been proven through the publication of more than 50 peer-reviewed studies using the same dataset since 2010. The publication of research studies using the BPRHS dataset is an ongoing process. The self-identification of the BPRHS participants as Puerto Ricans may bias the results by providing information pertinent to the Boston metropolitan area, and that may be generalizable in other northeastern cities densely populated by Puerto Ricans but not to other areas in the United States, particularly in Florida.

Significance

This research study may fill a public health gap by shedding light on the particular characteristics of LEP Puerto Ricans and by promoting understanding of the association between the preferred use of Spanish (language acculturation) and T2D prevalence and self-care behaviors in adult Puerto Ricans living in the continental United States (Boston metropolitan area). Filling that gap has public health relevance in health promotion, health communication, and health behavior interventions because Puerto Ricans are the second-largest Spanish-speaking population in the United States. Puerto Ricans show consistently high prevalence rates of T2D despite their access to care and federal and state-based social and financial aid programs due to their U.S. citizenship at birth, a factor that is not present in other Spanish-speaking immigrant populations that show lower prevalence rates of T2D and better health outcomes.

The intracultural disparities in Latino populations indicate that this dissertation study may address the prevalence and management of diabetes in meaningful ways. The outcome of the study may shed light on the disparities that adult Puerto Ricans may encounter by using Spanish as their preferred language. This preferred use of Spanish in a health care system primarily designed for English speakers impacts their health outcomes in a gradient described by their language acculturation as part of their overall acculturation process while living in the continental United States.

The social change implications of studying how language might impact prevalence and disparities in diabetes self-care behaviors in Puerto Ricans may open the door to generate successful health education and health promotion interventions (Himmelgreen et al., 2004). Such interventions may address the disparities experienced by Puerto Ricans and other Spanish-speaking populations, as published reports in adult populations have suggested (Hammons et al., 2019; Osborn et al., 2010; Tucker et al., 2010). The emergence of new knowledge on the effects of language acculturation in Puerto Ricans may provide a way to exert positive social change through the design and implementation of public health interventions directed toward Puerto Ricans rather than generalized interventions ignoring the heterogeneous nature of H/L populations. These interventions may account for the language heterogeneity and intracultural disparities among H/L populations and lead researchers and policy makers in changing their understanding of language effects on Puerto Ricans' diabetes prevalence and strategies to develop self-care skills. This new understanding may help Puerto Ricans modify their beliefs towards diabetes and other chronic diseases to change behaviors that may improve their health outcomes.

Summary

This dissertation study addresses language acculturation and public health gaps in the scientific literature in relation to a subset of the H/L population living in the United States. This population subset includes adult Puerto Ricans with diabetes living in the continental United States who took part in a large longitudinal study, the BPRHS. The aim of this dissertation study was to analyze the effect of language acculturation on the diabetes prevalence rate and diabetes self-care skills of adult Puerto Ricans in the Boston metropolitan area.

In the next chapter, I review the current literature addressing diabetes in the Puerto Rican population, as well as the major factors that contribute to diabetes and skills for managing the disease.

Chapter 2: Literature Review

Introduction

The purpose of this study was to generate knowledge regarding the effect that the language acculturation process has on adult Puerto Ricans in the United States. The study population included Puerto Ricans from the greater Boston area. The study involved the analysis of diabetes prevalence as well as self-care behaviors involving diabetes as a chronic disease.

The literature review in this chapter outlines multiple factors that affect the prevalence of diabetes in the H/L population, particularly in Puerto Ricans. This chapter provides information regarding diabetes epidemiology, factors contributing to diabetes, health outcomes in H/L populations, health literacy, and the impact of the language acculturation process in adult Puerto Ricans in the Boston metropolitan area, with emphasis on the prevalence of T2D. Next, I present a literature review concerning the study's theoretical frameworks (i.e., the HBM and TLB), as well as methodological strengths and limitations.

Literature Search Criteria

I located articles for this literature review through a search of the literature about the topics of diabetes and language and published in English and Spanish. The databases used to search for peer-reviewed journal articles were Google Scholar, PubMed, Medline, and EBSCO Host. The search terms used for the literature review were *diabetes*, *diabetes prevalence*, *diabetes management*, *spoken language*, *language acculturation*, *Spanish*, *limited English proficiency*, *Puerto Rico*, *Puerto Rican*, *Hispanic*, *Latino*, *culture*, *health* *literacy*, *health belief model*, *health outcomes*, *English proficiency*, *self-care*, and *self-management*. Search terms were used individually and in different permutations to find literature between 2014 and 2019, or earlier if the source contained seminal or theoretical information. Relevant articles were also identified from the reference sections of other peer-reviewed journal articles.

Literature Review

The literature that I reviewed included peer-reviewed journal articles, public health reports, and books. The review approach involved organizing the literature into seven main categories. The categories were diabetes epidemiology, acculturation, language barrier, health literacy, diabetes management, the HBM as the theoretical framework, and the use of secondary data analysis for quantitative studies. This review includes citations of research publications from peer-reviewed journals, quantitative studies, qualitative studies, mixed-methods studies, and public health reports.

Diabetes Epidemiology

Diabetes mellitus is a silent chronic disease that affects 8.5% of people (422 million) around the world (WHO, 2016) in all of its types (type 1, type 2, and gestational diabetes). In the United States, 9.4% of the population (30.3 million) has diabetes (CDC, 2017). The increased prevalence of diabetes in minority populations results in a larger impact on mortality. In 2015, diabetes mellitus was estimated to be the seventh leading cause of death in the United States (Murphy, Xu, Kochanek, Curtin, & Arias, 2017). However, for all minority groups (African American, American Indian or Alaska Native, Asian or Pacific Islander, and Hispanic or Latino), diabetes was the fifth leading cause of death, compared to Whites, for whom diabetes mellitus was the seventh leading cause of death (National Center for Health Statistics [NCHS], 2016).

H/L populations show prevalence rates of diabetes (all types) consistently higher than the U.S. national prevalence rate. For example, in 2015, the national prevalence of diabetes in adults was 9.4%, whereas the rate for Hispanics was 12.1% (CDC, 2017, 2018a). For H/L child and adolescent populations, there is a similar trend. Among U.S. children and adolescents (10-19 years of age), H/L youth have the third-highest incidence rate of T2D (18.2%) among minority populations (46.5% American Indian, 32.6% Black non-Hispanic), compared to Whites at 3.9% (CDC, 2018a). Gregg et al. (2018) analyzed U.S. population studies from 1985 to 2015 and identified that for people with diabetes, the death rate for all causes (23.1 per 1,000 person-years) and the death rate due to vascular disease (11.0 per 1,000 person-years) were twice as high for people with diabetes as for people without diabetes (11.0 for all causes and 5.2 for vascular disease). Similarly, Echouffo-Tcheugui et al. (2018) found an increased death rate due to cardiovascular disease in people with diabetes (*OR* = 2.64, 95% CI).

Statistics in Hispanic/Latino Communities in the United States

Few recent studies have been published on the diabetes epidemiology of H/L populations in the United States with disaggregated data by country of origin. One longitudinal national survey, the National Health Interview Survey (NHIS), has been collecting data through the U.S. Census Bureau since 1957 (CDC, 2019b). In 2016, Arroyo-Johnson et al. (2016) analyzed 15 years of self-reported diabetes prevalence trends from the NHIS, with data disaggregated by Hispanic subgroups. They found that among Hispanic subgroups, Puerto Ricans had the highest diabetes prevalence rate for individuals with less than high school education (17.6%), with a high school diploma/GED (9.6%), and with more than a high school diploma (Arroyo-Johnson et al., 2016). This finding indicates that Puerto Ricans with a high school diploma experienced a pronounced increase in diabetes prevalence compared to all other groups, including Whites (Arroyo-Johnson et al., 2016).

The Hispanic Community Health Study/Study of Latinos (HCHS-SOL) was a large study that specifically included the H/L population. The HCHS-SOL occurred between 2008 and 2011, and it included a total of 16,415 H/L male and female participants from four U.S. metropolitan areas with the largest numbers of Hispanics/Latinos (Bronx, NY; Chicago, IL; Miami-Dade County, FL; and San Diego, CA). The purpose of the HCHS/SOL was to examine the development and prevalence of chronic diseases (T2D, metabolic syndrome, etc.) in diverse H/L populations lacking sufficient data to estimate the epidemiology of their chronic diseases (Ennis, Ríos-Vargas, & Albert, 2011). Schneiderman et al. (2014) reported results from the HCHC/SOL showing variability in the prevalence of diabetes within Hispanic subpopulations recruited between 2008 and 2011. The highest prevalence rates of diabetes were observed in Hispanics from Central America (17.7%), Dominican Republic (18.1%), Puerto Rico (18.1%), and Mexico (18.3%). In comparison, the lowest prevalence rates of diabetes rates were in individuals from South America (10.2%), with a range of 10.2% in Hispanics of South American origin to 18.1% in Puerto Ricans and 18.3% in Mexicans (Schneiderman et al., 2014). These rates were higher than the national diabetes prevalence rate, ranging between 9.3% (CDC, 2015a) and 9.4% (CDC, 2017). Schneidermann et al. also reported another important factor related to diabetes, glycemic control, at a lower rate in Hispanics (48%) compared to Blacks (52.6%) and Whites (52.9%).

The HCHS/SOL study also addressed other important chronic diseases such as metabolic syndrome. Metabolic syndrome is a group of metabolic disorders defined for subjects showing at least three of the following criteria: abdominal obesity (waist circumference ≥ 102 cm in men and ≥ 88 cm in women; triglyceride level ≥ 150 mg/dL; high-density lipoprotein cholesterol (HDL-C) < 40 mg/dL in men and < 50 mg/dL in women; systolic blood pressure ≥ 130 mm Hg or diastolic blood pressure ≥ 85 mm Hg; and fasting blood glucose ≥ 100 mg/dL (Alberti et al., 2009; American Heart Association [AHA], 2018). Heiss et al. (2014) analyzed data from the HCHS/SOL study and reported that similar racial/ethnic disparities are present for metabolic syndrome. From 2003 to 2012, the overall prevalence of metabolic syndrome in the United States was 33%, with 33% in men and 35.6% in women (Aguilar, Bhuket, Torres, Liu, & Wong, 2015). In comparison, the overall rate of metabolic syndrome in H/L is slightly higher than the general population (34% in men and 36% in women). It is also variable within H/L subpopulations, with Puerto Ricans showing the highest overall prevalence rate of metabolic syndrome (37.1%) and South Americans showing the lowest overall prevalence rate (27.3%) of metabolic syndrome (Heiss et al., 2014).

The high prevalence rate of the metabolic syndrome may render H/L populations particularly vulnerable to comorbidities such as T2D (5 times higher for those with metabolic syndrome), cardiovascular diseases (3 times higher for those with metabolic syndrome), and different types of cancer such as renal, pancreatic, etc. (O'Neill & O'Driscoll, 2015). Mattei et al. (2016) reported similar results indicating a higher risk of developing metabolic syndrome in Puerto Ricans, showing the lowest alternate healthy eating index (HEI; 43.0) among H/L populations (Mattei et al., 2018). The HEI is a nutritional assessment tool that strongly predicts the risk for chronic diseases such as diabetes and coronary heart disease (Chiuve et al., 2012). Puerto Ricans in the United States also show high rates of prevalence of other chronic conditions such as asthma, cancer, heart disease, and hepatitis B and C, as well as mortality rates (CDC, 2015b, 2018b; El Burai Félix, Bailey, & Zahran, 2015; Jerschow et al., 2017; Kim et al., 2019).

The disparities observed in epidemiological data on diabetes, metabolic syndrome, and other chronic conditions in H/L populations in the continental United States provide an important consideration for this dissertation study in that most of the data used to calculate diabetes prevalence in most racial and ethnic groups, including H/L populations, still rely on self-reported data and direct patient–provider communication. In both instances, spoken and written communication between patient and provider requires language concordance for accurate reporting of data. When patient–provider communication faces language discordance due to a language barrier or limited English proficiency in patients who speak Spanish primarily, a limitation in the ability to self-report data in epidemiology and health research studies may ensue, creating information bias (Althubaiti, 2016). The disruption in communication due to language discordance may become a contributing factor to patient care disparities (Probst & Imhof, 2016).

The disparities detailed above are not restricted to disease prevalence rates in H/L populations. In the case of access to care, in 2013, Hispanics had an uninsured rate of 41.1%, a rate that was lowered to 34.1% after the Affordable Care Act's Health Insurance Marketplace started operating in 2014 (Martinez, Ward, & Adams, 2015). More recently, in a 2018 study, a 4.47% decrease in the uninsured rate between 2011 and 2016 was reported for U.S. citizens, a category that included all Puerto Ricans (Vargas-Bustamante, Chen, McKenna, & Ortega, 2018). However, such disparities do not appear to be uniform across all H/L populations. In the mid and late 2000s, several authors reported that Puerto Ricans had lower rates of access to health care and poorer health outcomes than other H/L populations (Vega, Rodriguez, & Gruskin, 2009; Zsembik & Fennell, 2005). These findings were confirmed in a 2018 report indicating that Puerto Ricans had the lowest change in the percentage uninsured rate (-3.96%) among H/L populations (Gonzales & Sommers, 2018).

Other forms of disparities have also been reported between island Puerto Ricans and Puerto Ricans in the continental United States. These disparities include key health care factors such as uninsured rates, which are lower in island Puerto Ricans (7.4% vs. 15.0 in the continental United States), with 45.9% of island Puerto Ricans on Medicaid compared to 18.0% of mainland Puerto Ricans. Additionally, 77.4% of island Puerto Ricans at risk for diabetes reported a blood sugar test in the previous 3 years, compared to 63.8% of mainland Puerto Ricans (Portela & Sommers, 2015). Although adult Puerto Ricans had the lowest insured rate among H/L populations (20.7%), they had the highest rates of delaying or not receiving medical care in the past 12 months due to cost (15.9%)

and nonreceipt of needed prescription drugs in the past 12 months (15.1%) compared to all other H/L populations (CDC, 2015b). These disparities are particularly important because the poverty rate in Puerto Rico in 2017 was 44.4%, more than 3 times the U.S. poverty rate of 12.3% for the same year, and the Medicaid program has more federal restrictions in Puerto Rico than in the continental United States (Fontenot, Semega, & Kollar, 2018; Portela & Sommers, 2015; U.S. Census Bureau, n.d.).

Factors Influencing the Prevalence Rate of Diabetes in Hispanics/Latinos

Multiple factors influence the prevalence rate of diabetes in H/L subpopulations, such as place of birth, U.S. region, length of stay in the United States, level of education, and socioeconomic status (Oza-Frank et al., 2013). Place of birth and length of stay in the United States are factors that provide higher risks of developing diabetes to Latinos born outside the United States compared to U.S.-born Latinos. The prevalence rate of diabetes in U.S.-born Latinos is 14.5%, whereas foreign-born Latinos have a diabetes prevalence rate that increases from 12.2% with 0-5 years in the United States, to 14.8% with 6-10 years in the United States, to 16.7% with 11-15 years in the United States, to 18.7% with 16+ years in the United States (Schneiderman et al., 2014).

The prevalence rate of diabetes varies among H/L subpopulations based on the U.S. region where they reside. Garcia and Ailshire (2019) found that Puerto Ricans had the highest diabetes prevalence rate adjusted by age and sex among Mexicans, Cubans, Dominicans, and South Americans in all U.S. regions (Northeast, Midwest, South, and West), except for Dominicans in the South. This report included data collected between 2000 and 2015 from the NHIS.

Oza-Frank et al. (2013) reported that foreign-born Latinos with ≥ 20 years of length of stay in the United States showed a higher risk of diabetes compared to those living in the United States for less than 20 years (hazard ratio, 1.60). The causes of this increased risk are multifactorial and may include Latinos' dietary and physical activity patterns, which may additionally contribute to the increase in their body mass index (BMI; Oza-Frank et al., 2013). Physical activity has negative effects when absent and positive effects when present. A recent systematic review study found that physical activity also helps with mental health issues related to diabetes by improving the symptoms of depression and biological outcomes (Narita, Inagawa, Stickley, & Sugawara, 2019).

The level of education and socioeconomic status factors are intricately interconnected in H/L populations. A language barrier or limited English proficiency may act as an impediment to furthering individuals' academic and workforce development (Moreno & Gaytán, 2013). From the HCHS/SOL, Schneiderman et al. (2014) reported that the highest prevalence rates of diabetes were observed in females with less than a high school diploma (20.1%) with an annual household income of less than $20,000 (18.5%), compared to females with more than a high school diploma (12.9%) with an annual household income of more than $75,000 (8.3%).

Acculturation

When foreign-born refugee and immigrant populations migrate into the United States, they start a long process of adaptation to the new society, culture, and environmental conditions. This long process is called *acculturation*, and it is not limited to refugee and immigrant populations. People coming from the island of Puerto Rico are not considered immigrants because they are deemed U.S. citizens at birth (U.S. Citizenship and Immigration Services [USCIS], n.d.), but they also go through the acculturation process, albeit their primary spoken language is Spanish.

The use of acculturation as a construct dates back to the 19th century, when it was applied in the fields of anthropology and archaeology (Boas, 1888; Powell, 1880). Boas (1940) considers that the concept of acculturation can be applied to the phonetic and morphological influences of one language over another, as a fluid remodeling and transfer of foreign elements influenced by the prevalent patterns of the new environment when two different populations come into contact (Boas, 1940). Acculturation was later adopted in psychology with a reconceptualization of the construct to be applied at the individual level (Graves, 1967). More recent applications include a study conducted by Lara et al. (2005), which indicated that the effect of acculturation in Latino populations is a complex and poorly understood process, with negative effects in health outcomes, behaviors, or perceptions of substance abuse, dietary practices, and birth outcomes; and apparent positive outcomes in self-perceptions of health.

More recently, Fox et al. (2017) assessed the acculturation process in minority populations in the United States, describing the inconsistent conceptualization and operationalization of acculturation as a variable in research studies. The authors pointed out that this inconsistency is also reflected in an apparent relationship between acculturation and health outcomes that make it difficult to determine the mechanisms that the life experiences in immigrant Latino populations have while individuals are living in a new environment (the United States). Fox et al. also raised concerns over acculturation's operationalization as a measure of the individual's internal state (attitudes, preferences, feelings) and operationalization factors such as cultural specificity (geographic origin or socioeconomic status), overemphasized proxies (language, length of stay in the United States, nativity, etc.), and dimensionality (alleged loss of native culture and adoption of host culture). Such factors are commonly found in minority research studies, usually characterizing H/L populations as a homogenous population, rather than pointing out the heterogeneous multiplicity of nations with common cultural traits, but with significant racial, cultural, and linguistic diversities that pose an immediate challenge to ascertaining what it means to be Hispanic or Latino.

As defined in Chapter 1, the terms Hispanic and Latino were used interchangeably in this dissertation study to match the nomenclature used in official reports and other research studies. However, it is pertinent to mention that the terms Hispanic and Latino have different geographic, cultural, and political connotations (Martin Alcoff, 2005), causing further confusion and inconsistency in public health reports at state and federal levels. This discrepancy is not exclusive to the Hispanic and Latino terms. For example, in research publications, it is common to find data categorized by race and ethnicity. In 1977, the U.S. Office of Management and Budget (OMB) published Directive 15, a standardization of the government's racial and ethnic classification system, and its revision in 1997 (OMB, 1977; 1997). Although there are categories for race and ethnicity, there is no specific definition of the term "race," beyond the definition of its four categories: American Indian or Alaskan Native, Asian or Pacific

Islander, Black, and White. Regarding the ethnic category, people are classified being of Hispanic origin, or not of Hispanic origin, largely ignoring the heterogeneous nature of H/L and other immigrant populations (NAP, 1996).

Self-identity is a major component of the acculturation process. Fox et al. (2017) described it as an internal state where the individual assimilates the new culture without losing its racial, ethnic, and cultural origins. Stokes-Brown (2012) indicates that Puerto Ricans tend to reject White and Black racial categories, regardless of their skin color, whereas some Puerto Ricans consider that if you are not Black, then you are White, a potential misconception that emerges from the different interpretation of the "Race" question in the U.S. Census survey (U.S. Census Bureau, 2018).

Although the extent of its effects is not clear, acculturation does affect immigrants' health beliefs and, consequently, health outcomes from chronic diseases such as diabetes (López et al., 2016). Such an effect should not be surprising since acculturation is not a short process, but rather a long process that accompanies the immigrants and migrants (Puerto Ricans) for as many years as the person lives in the host country, the United States. Avilés-Santa et al. (2016) described people with probable diabetes mellitus as people without self-reported diabetes or use of hypoglycemic medication, showing an overall prevalence of probable diabetes mellitus lower for individuals born in the United States compared to foreign-born individuals.

For Puerto Ricans, acculturation might occur differently than with other Spanish-speaking populations. According to Vasquez Guzman & Sanchez (2018), the citizenship status is an important factor in the acculturation process that is frequently unaccounted despite its integration with the social, economic, and political factors that impact the health outcomes of U.S. citizens positively (Vasquez Guzman & Sanchez, 2018). The citizenship status of Puerto Ricans does not translate into positive health outcomes, as is the case of non-Hispanic Whites. In a large metropolitan area such as New York City, where there are large concentrations of H/L subpopulations, Puerto Ricans tend to have the lowest annual median income ($38,220), compared to all other H/L populations such as Dominicans ($42,000), Mexicans ($48,195), Ecuadorians ($62,580), and Colombians ($64,838) (CUNY, 2014). Due to their citizenship status, Puerto Ricans have more access to care compared to other H/L populations. However, their level of access is more comparable to H/L populations than to Whites (Gonzales & Sommers, 2018). This similarity in access to care makes Puerto Ricans equally or more vulnerable to health disparities than other racial groups due mostly to language barriers, health literacy, and intracultural and gender disparities (DuBard & Gizlice, 2008; Schwartz, Unger, Zamboanga, & & Szapocznik, 2010; Zhang, Terry, & McHorney, 2014; Zsembik & Fennell, 2005).

Some studies have associated the acculturation process with other life factors such as nutrition, lifestyle, T2D, and health disparities with mixed results. González-Castro, Marsiglia, Kulis, and Kellison (2010) analyzed lifetime segmented assimilation trajectories related to quality of life indicators (life satisfaction, exercise behaviors, healthy and unhealthy dietary behaviors) using an eco-developmental framework. Only those with extreme upward assimilation (acculturation) trajectory showed the highest life satisfaction and lowest frequency of unhealthy food consumption (González-Castro, Marsiglia, Kulis, & Kellison, 2010; Pérez-Escamilla, 2011; Pérez-Escamilla & Putnik, 2007). Abraído-Lanza et al. (2016) analyzed the recent research on Latino immigrants, acculturation, and health, dividing the body of evidence in themes such as intrapersonal, interpersonal, social environmental, community, political, and global contexts. The authors incorporated integrative frameworks and contextual approaches to acculturation and its relation to health behaviors and recommended that future acculturation research in Latinos should include a life course approach with health varying based on age and stage of life course, immigrant status, race, and ethnicity (Abraído-Lanza et al., 2016).

As stated before, Puerto Ricans living in the continental United States, as well as refugee and immigrant populations, go through a lifetime acculturation process with particular effects on health and health outcomes when Puerto Ricans are subject to social influences and interact with people of dissimilar cultures (Schwartz, Unger, Zamboanga, & & Szapocznik, 2010). In 2017, Johnson, Cavanagh, Jacelon, and Chasan-Taber coined the term diabetes disparity after their systematic review of the scientific literature revealed that Puerto Ricans are disproportionately affected by diabetes. The authors recommended avoiding the use of the term Hispanic when describing H/L populations, due to their heterogeneous cultural beliefs and practices (Johnson, Cavanagh, Jacelon, & Chasan-Taber, 2017). This heterogeneity is the product of a combination of cultural beliefs and practices with the ability, or lack thereof, to speak English may impact the overall acculturation process in Puerto Ricans and other Spanish-speaking populations in the United States by influencing their food security status, beliefs, lifestyle choices, dietary quality, physical activity patterns, and increasing their risk to develop T2D

(López et al., 2016; Pérez-Escamilla, 2011; Pérez-Escamilla & Putnik, 2007; Wang et al., 2018; Wilson, Mulvahill, & Tiwari, 2017).

Throughout the acculturation process, H/L populations tend to shed their traditional dietary and food intake practices (beans, legumes, fruits, vegetables, and usually high fiber intake) and incorporate more of a Western diet with refined foods, fatty animal protein sources, and dairy products (Cuy Castellanos, 2015). This change in dietary quality or dietary acculturation may help explaining why H/L and other immigrant populations have a higher cardiometabolic risk when they have lived in the United States for ten years or more (Commodore-Mensah et al., 2016). In 2018, Mattei, McClain, Falcón, Noel, & Tucker (2018) reported an inverse length of residence effect in Puerto Ricans living in Boston. The only positive correlation was between a stronger U.S. orientation and dietary quality, particularly at higher income levels. This phenomenon is in direct contrast to a Mexican-Americans' report, where higher acculturation is inversely related to dietary quality (Mattei, McClain, Falcón, Noel, & Tucker, 2018). These findings may further support Spanish speakers' intracultural differences from the two largest H/L populations in the United States, Mexicans and Puerto Ricans. An analytical review of the minority research literature revealed that spoken language is a factor that affects health outcomes in minority populations whose primary language is not English (Flores G. L., 2013; Flores G., 2006; Flores & Vega, 1998). Also, Fox et al. (2017) reported that spoken language might indirectly affect limited English proficient Latino patients with T2D, particularly Puerto Ricans.

Fox et al. also indicated that the acculturation and health outcomes relationship is indirect in the form of discordance within the acculturation process, and it generates psychological stress that may mediate behavior, a transition from internal (attitude) to external (behavior) effects (Fox et al., 2017). Identifying the direct or indirect effects of language use and language acculturation in Puerto Ricans with diabetes (i.e., perceived barriers to care, perceived severity of the disease, and development of self-efficacy to manage diabetes) could fill a gap in the current literature. It may also present opportunities to address the effects of spoken language on diabetes by enriching the acculturation process of Puerto Ricans and prompting a change of beliefs, attitudes, and behaviors towards the improvement of disease management and health outcomes.

The language effect in Puerto Ricans is of a particular nature since they are deemed U.S. citizens at birth (USCIS, n.d.). Puerto Ricans born on the island of Puerto Rico arrive in the United States using Spanish as their primary language, similarly to immigrants. However, Puerto Ricans exhibit a phenomenon called circular migration, where Puerto Ricans live periods in the continental United States and the island of Puerto Rico because they can travel freely back and forth without the immigration issues that all other H/L populations endure, regardless if they are immigrants that go through the long, tedious and complex process of legal immigration, or if they remain in the United States as undocumented immigrants.As a process where individuals assimilate the host language (English) while maintaining or shedding their native language (English), the language acculturation phenomenon deserves further exploration since it may play a prominent role in the overall acculturation process.

Language and Language Acculturation

In 2017, 21.3% of the United States population spoke a language other than English, and 8.5% spoke English "less than very well." (U.S. Census Bureau, 2017). The "less than very well" category is the basis for the use of the term limited English proficiency/proficient (LEP), for individuals (usually foreign-born) that have limitations to communicate effectively in the English language. In other words, the primary use of a language other than English becomes a barrier.

There is a great body of research evidence involving ethnic and minority populations and the effects of their language barriers in health care (Arthur et al., 2015; Flores G., 2014; Flores G. L., 2013; Martinez G. A., 2015a; Ortega, McKenna, Langellier, Alcalá, & Roby, 2018; Showstack, 2019; Steinberg, Valenzuela-Araujo, Zickafoose, Kieffer, & DeCamp, 2016). The effects are shown when identifying spoken language as a factor that affects multiple quality of care factors such as access to care, quality of care, comprehension and adherence to treatment, patient-provider communication, patient discharge, patient-provider satisfaction, particularly in Spanish-speaking populations in the United States whose primary language is not English (Arthur et al., 2015; Flores G., 2014; Flores G., 2006; Flores G. L., 2013; Karliner et al., 2012; Martinez G. A., 2015a).

In addition to the difficulties encountered when speaking Spanish in the United States, there is also difficulty with the written language. There is a system-wide scarce availability of written or printed resources translated into Spanish. Even when resources are translated into Spanish, there are enough intralinguistic variations within the Spanish language, ensuing confusion and misinformation during the process of translating documents into Spanish if the important factor of localization (culture-specific aspects of language) and professional services are omitted (St. Germaine-McDaniel, 2010).

A simple yet powerful example of language, translation, and diabetes is the use of the word vegetables (English) and its equivalents in Spanish, *vegetales,* and *verduras*. Both terms generally refer to plants and edible plants in most Spanish-speaking countries. However, the term *verduras* is commonly used in Puerto Rico to name starchy tubers such as potatoes, sweet potatoes, ñame, yuca, yams, yautia, and plantains (Tesoro lexicográfico, 2016). In 2011, the CDC published a document in Spanish with food recipes to guide people with diabetes. The document mentioned the word "verduras" a total of 17 times, whereas the word vegetal was used 89% (8 out of 9) of the times to indicate the origin of margarine or oils used in the recipes, and 11% (1 out of 9) as the linguistic equivalent of the word vegetables (CDC, 2011). In a recent diabetes meal planning post, the CDC recommended to "skip the starch altogether" (CDC, 2019a). The interchangeable use of the terms vegetales and verduras might not be appropriate for Puerto Ricans since both terms bear different definitions and may cause confusion during daily food intake, potentially impacting people's glycemia (blood glucose levels) and diabetes status.

The recommendations for the translation of documents into a language (Spanish) spoken in a country (United States) made up of multinational speakers of the same language (H/L populations) should involve the use of multiple layers of translators and reviewers from multiple native countries. This multilayer approach is meant to ensure acceptable translations for all regions or multiple final translated versions (Wild et al., 2009). The linguistic equivalency from one language to another is not the only confusing factor for diabetes patients that choose Spanish as their preferred language.

The intralinguistic heterogeneity within Spanish-speaking populations of the twenty countries where Spanish is the official language and Puerto Rico (a U.S. territory) has made it difficult for scholars to classify the Spanish dialects because the regional versions of Spanish do not coincide with geographic borders (Erker, 2018). In the context of diabetes, people may have problems understanding recipes and food recommendations due to the heterogeneity in the naming of fruits, vegetables, and spices, further contributing to the confusion and lack of clear understanding of recommendations. For example, beans are some of the most common foods used worldwide. The linguistic equivalents of the term beans in Spanish are *frejoles, porotos*, and *judías* (South America), *frijol* (Mexico and Central America), and *habichuelas* (Puerto Rico) (RAE, n.d.). Beans are important and healthy food staples, deemed as "superfoods," they have high fiber content and low to medium glycemic indices, a measure that indicates how fast glucose is elevated in the blood (ADA, 2019; Harvard Health, 2018).

The divergence in health outcomes experienced by Spanish speakers in the United States is described in multiple studies. For example, Eamramond et al. (2009) studied 1,492 Hispanic participants from the Multi-Ethnic Study of Atherosclerosis (MESA), using the language spoken at home and proportion of life in the United States as predictors in the MESA study. The results indicated consistent disparities for Spanish speakers in poor control of cardiovascular factors (blood pressure and LDL-cholesterol) and fasting blood glucose. Similarly, Spanish speakers showed less educational attainment, family income, health insurance, and duration of residence in the United States (Eamramond et al., 2009). This study revealed a bidirectional relationship between the Spanish language spoken at home by Hispanics that speak only Spanish and a length of residence of less than half their lives in the United States, showing higher rates of hypertension, hypercholesterolemia, and diabetes.

In a more recent study conducted in an integrated public health system, Hacker et al. (2012) included 1,425 limited English proficient (LEP) patients from Cambridge, MA. The limited or non-English proficiency of patient populations hindered their effective communication with health care providers. Such a detrimental effect was improved when professional medical interpreters mediated the medical encounter, increasing the access and quality of care, showing greater satisfaction with care, increased compliance with treatments, and reduction of the number of visits to the emergency department in patients with diabetes (Hacker et al., 2012).

Leung et al. (2016) showed contrasting results when comparing Latino and Asian groups of patients by the preference of language in relation to diabetes care quality. After adjusting for socioeconomic and health characteristics, only Asian patients suffered disparities in diabetes care quality by English language preference (Leung, Vargas-Bustamante, Martinez, Chen, & Rodriguez, 2016). Although this study showed similar results to a Singapore study with Indian (Asian) patients speaking Tamil in an English-dominant healthcare setting (Zheng et al., 2012), it provided limited knowledge because it did not account for unobserved factors such as individual beliefs, cultural factors, and provider variation (Leung, Vargas-Bustamante, Martinez, Chen, & Rodriguez, 2016). Fox et al. (2017) reported such factors to be intricately associated with patients' beliefs and attitudes towards health and health care. The spoken language might have an indirect effect in LEP Latino patients with T2D, particularly Puerto Ricans. This effect is observed as discordance between the internal (attitude) and external (behavior) aspects of their acculturation process (Fox et al., 2017).

In a systematic review and meta-analysis study, Njeru et al. (2017) indicated that limited English proficiency (LEP) in Spanish-speaking populations is considered a risk factor for health disparities. Such risks occurred at multiple access and outcome levels, such as poorer overall health status, limitations in access to health care, and poor understanding of medical information. These limitations consequently generated lower adherence to medical treatments and disease-specific outcomes, particularly with long-term (chronic) diseases (Njeru et al., 2017).

The language barriers present a particular challenge during the interactions that patients and healthcare providers have during and after a medical encounter. Terui (2017) argues that language barriers contribute to health disparities that derive from patient-provider communication, such as treatment adherence and, ultimately, health outcomes. Fernández et al. (2017) conducted a multi-year study with diabetes patients, including three groups, LEP Latinos, English-speaking Latinos, and Whites. The results indicated that LEP Latinos scored higher for non-adherence to oral medication and insulin use compared to the other two groups.

Some studies indicate that limited English proficiency or language-related factors, do not have a significant effect on aspects of healthcare, such as pediatric hospital readmission (Ju, Luna, & Park, 2017). However, other studies have proven the opposite, the negative effects of the language barrier in pediatric health care (Goenka, 2016; Showstack, 2019). Some dissertation studies have shown a similar lack of effect of bilingualism or biculturalism as predictors of executive functions and the likelihood of obesity (Caton, 2011; Vallejo, 2017). Albeit those punctual results, the relationship between language barriers and limited English proficiency is well established in the scientific literature, particularly in peer-reviewed publications, as shown throughout this dissertation.

The contribution of language barriers to health disparities goes beyond the communication aspect. It presents a unique challenge to conceptualize what a language barrier in healthcare is moving away from a simplistic approach to treating such barriers with the use of medical interpreters but rather with a systemic approach to ensure the proper delivery of care (Terui, 2017). Parsons, Baker, Smith-Gorvie, and Hudak (2014) conducted a qualitative study in Toronto, a multicultural Canadian city where 160 languages are spoken, an urban situation comparable to several U.S. northeastern states. The authors reported that a physician's decision to 'get by' or 'get help' is subjective and included time/time constraint, acuity of situation, and ease of use/availability of translation aids. These three interrelated factors pose a dilemma for physicians trying to provide care to patients while facing language barriers in a fast-paced healthcare setting (Parsons, Baker, Smith-Gorvie, & Hudak, 2014).

Martinez (2010) described the unique context of language barriers in healthcare, proposing a theory of language barriers that identifies language barriers as a public health threat that goes beyond the face-to-face clinical encounter between patients and health care professionals. The limited English proficiency of Spanish-speaking populations is experienced in society in general, in what he calls a linguistic gradient (Martinez G., 2010). This linguistic gradient is described based on how monolingual English-speaking Latinos having better health outcomes than bilingual Latinos, and these have better health outcomes than monolingual Spanish-speaking Latinos. This linguistic gradient and its epidemiological counterpart is similar to the association between socioeconomic status, race, and health in the United States and globally (Williams, Priest, & Anderson, 2016).

In 2015, Martinez described that most of the research involving Spanish language and health care in the United States covers three main areas of research: language concordance (same language between patient and health care provider), use of medical/healthcare interpreters (bridging the communication gap), and the use and teaching of Spanish among health care professionals. Terui (2017) argues that this traditional conceptualization falls short of including the indirect health disparities regarding the lack of treatment adherence and patients' perception of dissatisfaction and discrimination. Other studies have also demonstrated that language discordance between patients and health care providers hinders the health care of Spanish-speaking Latinos and that language concordance between patients and health care providers generates a positive effect on Spanish-speaking patients (Parker et al., 2017; Tassavor & Chen, 2018).

The nature of continuing with the publication of descriptive studies documenting the presence of the language barrier in healthcare rather than implementing systemic interventions is discouraging and counterproductive from delivery of care and quality of care perspectives (Flores G., 2014; Schwei et al., 2016; Terui, 2017). The second area of the research described by Martinez (2010) involved the use of medical/healthcare interpreters in clinical encounters between LEP patients and English-speaking health care professionals. This area of research has produced several studies confirming that the use of ad hoc (untrained) interpreters not only extends the time of the clinical encounter but it also presents inaccurate language interpretation with a large number of errors with potentially negative consequences for the patient (Flores, Abreu, Barone, Bachur, & Lin, 2012; Nápoles, Santoyo-Olsson, Karliner, Regorich, & Pérez-Stable, 2015).

The third area of research described by Martinez (2010) is connected to the use of ad hoc and untrained interpreters, coming from the misconception that bilingual individuals, whichever their bilingualism level is, can serve as language interpreters. These bilingual individuals grew up learning Spanish, or any other non-English language, in their homes or through family/community interactions. Their lack of academic or professional training in the non-English language limits their capacity to perform linguistic transfers in a professional setting such as healthcare (Magaña, 2015).

This lack of systematic exposure to academic and professional training does not allow them to transfer the literacy skills from the strong language (English) into the heritage language (Spanish or another non-English language) (Martinez G. A., 2015b). A recent national survey of medical schools in the United States indicated that 73% of those schools offer a curriculum of medical Spanish taught by students or faculty and mostly as elective courses. The remaining 32% of the medical schools planned to incorporate medical Spanish into their curriculum (Morales et al., 2015). The academic approach in medical schools to address language barriers remains unclear. Diamond & Jacobs (2010) indicated that teaching Medical Spanish to health care providers may indeed contribute to health disparities (Diamond & Jacobs, 2010).

In 2015, a qualitative study with Spanish-speaking patients in North Carolina identified three recurring themes, inconsistent collection of patients' names, lack of language access services at the front desk/registration area, and perceived discrimination (Calo et al., 2015). In a 2017 qualitative study, the authors identified a theme from interviews with medical and nursing students that had undergone training on how to care for patients with limited English proficiency. The identified theme was negative role modeling experiences, characterizing the role modeling as "indifferent" (Kenison et al., 2017). In 2016, a qualitative study with pediatric patients' mothers also identified a similar negative impact on LEP patients' care due to language barriers. The authors described how pediatric patients' mothers characterized their health care encounters as a "battle," showing a preference for bilingual staff, while "getting by" with their limited language skills or using family members rather than feeling like a burden or being singled out (Steinberg, Valenzuela-Araujo, Zickafoose, Kieffer, & DeCamp, 2016).

Most of the research literature indicates that the use of interpreters favors the LEP patient's throughput time from arrival to the hospital to discharge, patient care, and better diabetes outcomes (Grover, Deakyne, Bajaj, & Roosevelt, 2012; Luan Erfe et al., 2017;

Njeru et al., 2017). Albeit those consistent findings, and the ethical implications of providing health care in English to LEP patients, the use of trained interpreters in medical encounters is inconsistent (Basu, Costa, & Jain, 2017; Jacobs, Ryan, Henrichs, & Weiss, 2018; Mayo et al., 2016). A retrospective study in a large academic healthcare setting in Boston identified that 66% of LEP patients did not have interpreters during their medical encounters, but that 30-day postdischarge emergency room readmission and 30-day readmission rates showed no difference with or without the use of an interpreter (López, Rodriguez, Huerta, Soukup, & Hicks, 2015). The struggle with language barriers is a reality for people in the United States of America, but also for other countries with large immigrant populations or with populations that speak a language other than the host country's official language (Ali & Watson, 2018; Attard et al., 2015; Gray & Hardt, 2017).

Given these multiple consistent reports, medical schools and health systems should incorporate more wholesome and culturally-oriented approaches that do not focus only on language interaction, and that can be practiced systematically to address the language and organizational barriers with LEP patients. These approaches should follow the recommendations of the Culturally and Linguistically Appropriate Service (CLAS) standards and The Joint Commission (TJC, 2014; OMH, 2013). Both sets of recommendations are based on Title VI of the Civil Rights Act of 1964 (LEP.GOV, 2018).

Although the language is an essential component in the direct communication between two or more people, the dimension of language is vastly more comprehensive.

The acculturation process that foreign-born individuals undergo when living in the United States includes a major process called *language acculturation*. The language acculturation process involves the assimilation and use of the second language (English) in daily situations. It would be expected to find that people with higher language acculturation have more access to opportunities in education, work, and climbing the social ladder. However, the general acculturation and language acculturation processes seem to be very complex and intricately intertwined with factors such as age at arrival, life events trajectories, and stress (Arévalo, Tucker, & Falcón, 2014).

Research studies published within the past 20 years have identified that language acculturation has effects on diabetes knowledge, health-promoting lifestyles, diabetes management, higher cardiovascular risk factors, food intake patterns, diabetes prevalence, and diabetes complications in Spanish-speaking populations in the United States (Chilton, Hu, & Wallace, 2006; Eamramond et al., 2009; Fitzgerald et al., 2006; Kandula et al., 2008; Mainous III et al., 2006). More recent publications also associate language acculturation with diabetes incidence, diabetes management and control, dietary acculturation, the effect of social factors, and diabetes management self-efficacy (Afable-Munsuz, Gregorich, Markides, & Pérez-Stable, 2013; Baig et al., 2014; Cuy Castellanos, 2015; López et al., 2016; Mansyur, Rustveld, Nash, & & Jibaja-Weiss, 2016; Van Rompay et al., 2012; Yoshida et al., 2016). The complexities of the daily disease management in patients with diabetes are reported in detail below.

Diabetes Management

T2D is a chronic disease that requires daily and long-term patient management with a focus on lifestyle management and diabetes self-management education and support (Davies et al., 2018). Patients with T2D need to balance two main areas, internal and external. The internal area involves the development of skills, usually referred to as self-care or self-management skills to manage the disease. The external area involves the external factors that influence the disease management process.

Internal Areas: Self-Care Behaviors

The American Association of Diabetes Educators or AADE (2017) defines seven key areas for diabetes educators to focus on in their educational work with diabetes patients. The key areas are healthy eating, being active, monitoring, taking medication, problem-solving, reducing risks, and healthy coping (AADE, 2017). These key areas include dietary patterns, physical activity, health promotion, and knowledge of preventive medicine.

Although these areas are essential to managing diabetes, the number and complexity of the daily tasks that involve the self-management of diabetes may be overwhelming and very time consuming, regardless if it is type 1, type 2, or gestational diabetes. The American Diabetes Association (ADA) defines the following daily tasks for diabetes patients (ADA, 2016): Nutrition (choosing what, when, and how much to eat), physical activity, medication management, blood glucose monitoring, attending healthcare appointments and learning about diabetes. The ADA also puts the responsibility of these tasks in the hands of patients.

Recently, Shubrook, Brannan, Wapner, Klein, and Schwartz (2018) conducted a study with certified diabetes educators to assess the time required by two types of patients to perform two tasks. The two types of patients were an adult patient with T2D for at least one year and a school-age child with T1D for at least one year. For adult patients, task 1 was managing oral medications, and task 2 was self-monitoring of blood glucose (SMBG) and all the components of diabetes management. For the children, task 1 was managing four daily insulin injections, and task 2 was self-monitoring of blood glucose. The mean times for adult patients were 66 minutes (task 1) and 234 minutes (task 2). The mean times for school-age children were 78 minutes (task 1) and 305 minutes (task 2) (Shubrook, Brannan, Wapner, Klein, & Schwartz, 2018).

In addition to the time and complexity involved with diabetes self-care behaviors, the development of these patient self-care skills should be taught by diabetes educators and learned by patients with diabetes. Thus, attending diabetes management education programs should be one of the first steps after a diabetes diagnosis. In contrast with this process, most patients do not attend diabetes management education programs. In 2014, the Centers for Disease Control and Prevention reported that only 7.2% of adult patients (45 to 74 years of age) and 5.9% of young adult patients (18 to 44 years of age) diagnosed with diabetes attend diabetes self-management education programs during their first year of diagnosis (CDC, 2014). The attendance to these programs is different also by region, with 5.7% of patients from the Southern states showing the lowest attendance, and 6.9% of patients from the Northeastern states, where Boston is located, showing the lowest attendance (CDC, 2014; U.S. Census Bureau, n.d.).

The development and practice of diabetes self-care behaviors seem to be indirectly affected by health literacy and self-efficacy, a construct of the health belief model (Lee et al., 2016). In H/L populations, self-care seems to be related to gender, with men receiving more support and reporting better self-care adherence than women. In contrast, women reported more barriers, less support, and more negative reinforcement (Mansyur, Rustveld, Nash, & Jibaja-Weiss, 2015). Smith-Miller, Berry, DeWalt, and Miller (2015) reported similar results among Spanish-speaking H/L immigrants having unsuccessful management of diabetes, especially without linguistically and culturally appropriate interventions (Smith-Miller, Berry, DeWalt, & Miller, 2016).

In a 2016 study with African American and H/L patients with diabetes, self-efficacy was not associated with or mediated any self-care area in H/L patients with diabetes (Hernandez et al., 2016). Other studies have described health literacy as a possible modifier in patients' disease self-management. However, the evidence remains elusive and unclear (Marquez, Calman, & Crump, 2019). Although the relationship between health literacy and the development of self-care behaviors to manage diabetes is still inconclusive, the combination of health literacy and limited English proficiency in Spanish-speaking patients is a combination that researchers seldom address, with few measuring instruments produced to assess health literacy in LEP individuals (McKee & Paasche-Orlow, 2012).

A systematic review and meta-analysis in 2017 identified that although there are multiple intervention types to address diabetes self-management in LEP patients. The most effective interventions seem to be the ones delivered face-to-face with improvement in diabetes knowledge, self-efficacy, quality of life, and other comorbid factors (Njeru et al., 2017). Indelicato et al. (2017) found out that higher levels of hemoglobin A1C (HbA1C) had a statistically significant association with higher perceived interference with daily activities and higher perceived diabetes severity. Also, lower self-efficacy was closely associated with higher diabetes and psychological distress and poorer glycemic control (Indelicato et al., 2017). Diabetes in LEP patients should also be assessed with an ecological perspective, including their environment and the interaction with societal organizations regarding education, work and income, and their physical environment. The interaction of those socioeconomic and environmental elements impacts the internal and external factors affecting the empowerment and development of self-care skills to properly manage diabetes (Lee et al., 2016).

External Areas: Socioeconomic Status, Physical Environment, and Nutrition

The external factors (social, economic, political) of the H/L populations living in the United States, together with their acculturation process, define a heterogeneous reality that tends to coexist with unfavorable circumstances that make disease processes worse synergistically. This phenomenon is called syndemics (Hart & Horton, 2017). As an emerging phenomenon, syndemics describes the tendency to overlook the interaction of biological, social, and ecological factors that contribute to diseases, and that should constitute the foundational translation of medical and public health research into public policy (Mendenhall, 2017; Singer, Bulled, & Ostrach, 2017). The external areas to be analyzed in this section include socioeconomic status, physical environment (residential segregation and physical space), and nutrition (food insecurity) due to their direct and indirect effects on diabetes management and health outcomes (Gonzalez-Zacarias, Mavarez-Martinez, Arias-Morales, Stoicea, & Rogers, 2016).

Socioeconomic status and physical environment. The socioeconomic status (SES) contains multiple factors that impact people's health. For this dissertation, I concentrated on two of those factors, educational attainment and income level. In 2017, a report from the Pew Research Center indicated that Puerto Ricans born on the island have a higher rate of attaining a bachelor's degree or higher (21%) than those born in the continental United States (18%). Also, even though Puerto Ricans have a higher median annual income ($28,600) than other Hispanics in the United States ($25,000), Puerto Ricans show a higher poverty rate (23%) compared to other Hispanics in the United States (19%) (Pew Research Center, 2019). In Boston, 45.7% of Puerto Ricans live below the poverty line, with a median household income ($18,423) that is almost half of the other Latino groups ($34,544), with 59.2% of Puerto Rican children in Boston living in poverty, more than twice the non-Latino children (24.3%) (Boston Planning & Development Agency Research Division, 2017).

In a 2014 study, educational attainment was associated with diabetes in Hispanic men with less than high school, having 64% higher odds of having diabetes compared to Whites and non-Hispanic Blacks (Whitaker et al., 2014). Intergenerational transmission of educational attainment, from parents to children, is lower in immigrant families (at least one foreign-born parent) than in U.S.-born families. However, this distribution varies within immigrant populations with less educational transmission among those populations that migrate into ethnic enclaves and rely more on ethnic resources (Luthra &

Soehl, 2015). A residential segregation study comprising data between 1980 and 2010 indicated that Puerto Ricans are largely concentrated in the East Coast (New York, Florida, New Jersey, Pennsylvania, and Massachusetts), interact less with other Hispanic groups, and are less isolated living with members of their own group (Iceland, Weinberg, & Hughes, 2014). The ethnic enclave of Puerto Ricans is in decline, and it does not seem to explain the lower rates of higher educational attainment past the bachelor's degree. However, other factors such as self-identification may partially explain such lack of educational attainment, with Latinos self-identifying as Mexicans (11.2%), Central Americans (12.1%), Dominicans (18.1%), and Puerto Ricans (18.6%) showing much lower college attainment than Cubans (32.6%) and South Americans (38.7%) (Ayala & Chalupa, 2016). In a 2016 study, educational attainment was correlated with skin color. Hispanics of darker skin tone were significantly less likely to complete high school and less likely to attend college and obtain a bachelor's degree or higher (Ryabov, 2016). In contrast, when states systematically embrace and expand immigrant inclusion at the policy level, Latinos are more likely to stay in and graduate from high school (Condon, Filindra, & Wichowsky, 2016).

Hernandez et al. (2016) identified a negative association between educational attainment and diabetes self-care behaviors in Latinos. The authors reported that Latinos with lower educational attainment (less than high school) had better dietary behaviors (consuming more fruits and vegetables and less fats) than those with higher educational attainment (some college or postgraduate education), describing a U-shaped curve (Hernandez et al., 2016). The study was conducted in Chicago, and it most likely included Mexicans. In the case of Puerto Ricans, Mattei, McClain, Falcón, Noel, & Tucker (2018) reported that a U-shaped effect is also observed with higher income Puerto Ricans showing higher-quality dietary practices compared to lower-income Puerto Ricans (Mattei, McClain, Falcón, Noel, & Tucker, 2018).

The heterogeneity of H/L populations shows not only intracultural diversity but also differences in major chronic diseases, mortality rates, and potentially preventable hospitalizations compared to Whites in the United States (Feng et al., 2018; Lopez, 2014). Although H/L populations are generally associated with having low socioeconomic status (SES), their risk for cardiovascular diseases (CVD) and mortality rates seem to be unexpectedly lower compared to Whites in the United States. Socioeconomic status and low educational attainment impact future earnings and healthcare utilization, turning individuals with those characteristics into high-cost healthcare users (Fitzpatrick et al., 2015).

In addition to SES, discrimination is a factor that immigrants have to face frequently, either implicitly or in more subtle ways. Molina & Simon (2014) described how daily discrimination was more strongly associated with the count of chronic conditions, moderated by household income but more prevalently in middle-income Latino than in low-income Latinos (Molina & Simon, 2014). Other studies have not identified neighborhood problems or residential segregation either as factors that increase the risk of diabetes risk or alter the levels of hemoglobin A1C (Grigsby-Toussaint, Jones, Kubo, & Bradford, 2015; Moreno et al., 2014).

Language, acculturation, and SES are intertwined in H/L populations, especially because researchers frequently use and measure language as a proxy of acculturation (Baig et al., 2014; Fortmann et al., 2015; Tamí-Maury et al., 2017). Therefore, higher acculturation usually means higher SES due to more English-proficiency, educational attainment, and, consequently, better job opportunities and income levels (Baig et al., 2014; O'Brien, Shuman, Barrios, Alos, & Whitaker, 2014). Although H/L immigrants living in the United States may have a low level of acculturation, they seem to have an increased risk of developing diabetes by changing their traditional cooking and nutrition habits for more convenient practices due to time constraints in their daily routine (O'Brien, Shuman, Barrios, Alos, & Whitaker, 2014).

Nutrition and food insecurity. The connection between nutrition and T2D is well documented in the research literature. Although diabetes is the long-term, uncontrolled, high concentration of glucose (sugar) in the blood (glycemia), diabetes is caused primarily by lifestyle and nutritional choices. Even a single day of high-fat food intake alters the body's energy metabolism by lowering the body's sensitivity to insulin, the glucose-lowering (hypoglycemic) hormone produced by the pancreas (Parry, Woods, Hodson, & Hulston, 2017). This effect is exacerbated when nutritional excess and sedentarism interact to increase the risk of T2D, obesity, and cancer (Czech, 2017).

The American Diabetes Association (ADA) recommends nutrition therapy as one of the strategies to manage the outcomes of people with diabetes. The ADA sets specific goals: 1) Promote and support healthy eating patterns, emphasizing the intake of appropriate portions of nutrient-dense foods; 2) Address individual nutrition needs considering language, culture, and health literacy (numeracy) needs; 3) Maintain the pleasure of eating (food choices) using nonjudgemental messages; and 4) Provide practical tools to individuals to develop healthy eating patterns (ADA, 2019). The integration of nutrition therapy with emotional therapy and diabetes self-management education is proposed as an ongoing process, to be assessed and reinforced annually, and recognizing the contribution and underutilization of family members in ensuring patient's adherence to nutrition therapy (Gallo et al., 2015; Powers et al., 2017).

Old research evidence points to mixed results when studying acculturation, lifestyle, and diet in H/L populations, with some protective effects due to high fiber intake and some detrimental effects due to high fat and refined sugar intake (Pérez-Escamilla & Putnik, 2007). Recent studies indicate that H/L populations with low acculturation and low-income have better dietary quality (high consumption of fiber, fruits, and vegetables). In contrast, meat and fast-food consumptions are considered luxuries and therefore associated with more income and pride (Cuy Castellanos, 2015). The relationship between food, culture, and lifestyle in H/L populations is complex and influenced by abilities (nutrition literacy), pyschosocial (beliefs and behavior), and environmental factors (access to food) (Cuy Castellanos, 2015; López-Cepero, Frisard, Bey, Lemon, & Rosal, 2019; Velardo, 2015).

Access to food (food security), or the lack thereof (food insecurity), is an important factor in determining the dietary practices by encouraging maladaptive behaviors and overeating (Stinson et al., 2018). In Canada, food-insecure households have twice the risk of developing T2D (Tait, L'Abbé, Smith, & Rosella, 2018). Similarly, Weaver and Fasel (2018) conducted a systematic review and reported a statistically significant association between food insecurity and chronic diseases such as diabetes, hypertension, and other diet-related chronic diseases (Weaver & Fasel, 2018).

In 2018, the U.S. Department of Agriculture reported that in 2017, 11.8% of U.S. households experienced food insecurity at some point during the year (Coleman-Jensen, Rabbitt, Gregory, & Singh, 2018). With or without a diabetes diagnosis, food insecurity affects people in a gradient form. A recent report showed the likelihood of food insecurity in 39% of people with pre-diabetes, 53% of people with diagnosed diabetes, and 81% of people with undiagnosed diabetes (Walker, Grusnick, Garacci, Mendez, & Egede, 2019).

Food insecurity has wide implications in H/L populations. Diabetes self-care behaviors and glycemic control are associated with food insecurity (Berkowitz, Gao, & Tucker, 2014; Heerman et al., 2016). Researchers used data from the Boston Puerto Rican Health Study (BPRHS) and identified that food insecurity was also associated with lower overall dietary quality and a lower intake of fruits and vegetables (Berkowitz, Gao, & Tucker, 2014). Food insecurity is also inversely related to language proficiency, with higher English proficiency showing lower food insecurity and poorer glycemic control (Kamimura et al., 2017; Shalowitz et al., 2017). Wong et al. (2016) also used BPRHS data to identify a fast decline in the executive function of Puerto Ricans with food insecurity in Boston (Wong et al., 2016).

The interaction of socioeconomic status and food insecurity in people with diabetes negatively affects disease management and glycemic (Mayer, McDonough, Seligman, Mitra, & Long, 2016). Additionally, in a recent retrospective longitudinal study, Berkowitz, Basu, Meigs, and Seligman found that food insecurity was associated with a significant increase in annual health care expenditures. People with food insecurity (14%) had an extra $1,863 in annual healthcare expenditures, comprising an estimated total nationwide extra expenditure of $77.5 billion (Berkowitz, Basu, Meigs, & Seligman, 2018).

Few studies have addressed the food insecurity factor in low-income Puerto Ricans from a belief-behavioral perspective. Kollannoor-Samuel et al. (2012) conducted a statistical analysis that described the association between food insecurity and four dimensions of barriers: 1) Enabling factor barrier (lack of money and insurance impacting visit to a physician and medication intake); 2) Barrier to physician access (transportation, understanding doctor, referrals); 3) Medication access barrier (transportation, understanding the use of medication); and 4) Forgetfulness barrier (forgetting medical appointments and medication intake). Food insecurity turned out to be a strong risk factor for lacking enabling factors, medication access barriers, and forgetting to take medications and attending doctor's appointments. This study is particularly relevant since it is specific to Puerto Ricans in the northeast (Connecticut), a population that tends to have lower annual household income among H/L populations (Kollannoor-Samuel et al., 2012). Additionally, it sheds light on how the perception of barriers such as income, transportation, and understanding of physicians and medication use negatively impacts Puerto Ricans' self-efficacy (Berkowitz, Gao, & Tucker, 2014; CUNY, 2014; Proctor, B. D.; Semega, J. L.; Kollar, M. A., 2016).

Most of the external areas affecting the management of diabetes are directly or indirectly affected by the diabetes patient's perceptions and beliefs, language ability, and health literacy. Most Spanish-speaking LEP patients are at a disadvantage since their perceptions and actions are influenced by the interaction of their language ability and their acculturation processes, as described throughout this chapter. Their perceptions and beliefs can be explained through the lens of the health belief model's constructs (behavioral framework), in combination with the theory of language barriers (psychosocial framework) to be described next.

Theoretical Framework

The Health Belief Model

The Health Belief Model (HBM) is the theoretical framework that provides the constructs for this dissertation study. The HBM was originally developed in the 1950s by social psychologists (Hochbaum, 1958; Rosenstock, 1960). The HBM constructs are based on the principles of the Social Cognitive Theory (SCT). These principles use a value-expectancy model for cognitive processes (thinking, hypothesizing), proposing that behavior is the reflection of how individuals value an outcome (value=avoiding disease, outcome=well-being), and their assessment or expectation that a given action (health behavior) will achieve such outcome (Skinner, Tiro, & Champion, 2015).

For more than six decades, the researchers developing the HBM described how the HBM focuses on the elements that encourage and discourage people's health behaviors. Therefore, the use of the HBM as a theory is an attempt to explain people's lack of participation in disease screening and prevention of asymptomatic diseases and people's responses to experienced symptoms (Hochbaum, 1958; Kirscht, 1974; NCI, 2005; Rosenstock, 1960; 2000). In its original conception, the HBM involved four constructs of perception: Perceived susceptibility, perceived barriers, perceived severity, and perceived benefits (Champion & Skinner, 2008). The four perception constructs do not follow a specific sequence, and they may happen all at once. Over time, two additional constructs were added: cues to action and self-efficacy to reflect the decisions people make when adopting health behaviors (Glanz, Rimer, & Viswanath, 2015). Different than the original four perception constructs, the two newer constructs may resemble a sequence going from cues to action (readiness to change) to self-efficacy (confident to taking action; NCI, 2005).

The original application of the HBM addressed the lack of response to disease screening campaigns (i.e., tuberculosis), and it was later expanded to more general people's behavioral responses to detect diseases with available treatment and even cure (Skinner, Tiro, & Champion, 2015). A 2018 study proved that the HBM is an effective and current theoretical framework for lifestyle interventions for people with diabetes through a systematic review and meta-analysis that indicated that the HBM helps in the understanding of a specific problem (disease) in a particular population within its context (environment) using lifestyle interventions better than other health behavior models such as the PRECEED-PROCEED model (identifying enabling factors through the assessment of the quality of life), and the Transtheoretical Model in the reduction of HbA1c (Doshmangir, Jahangiry, Farhangi, Doshmangir, & Faraji, 2018).

The success of the HBM lies in using people's beliefs to predict people's behaviors towards health, health concerns, or risky behaviors such as sexual behaviors (Coreil, 2010). In 1992, Bandura described the belief of self-efficacy as a factor that influences people's feelings, thoughts, and actions (Bandura, 1992). This self-efficacy belief is subject to its environment (instating conditions), which affects the motivation (perceptions) and action (behavior). It is possible then that people's behavior contributes to the occurrence of chronic diseases (such as T2D and cardiovascular diseases), particularly present in populations with sedentary lifestyles and poor nutritional habits (Cecchini et al., 2010). Therefore, people's behavior may be considered a potential risk factor to develop T2D (Rahati, Shahraki, Arjomand, & Shahraki, 2014).

Gherman et al. (2011) proved the relevance of self-efficacy with a review of 48 studies that measured beliefs, perceptions, cognitions, and their relationships with glucose levels and other adherence behaviors. The authors identified that self-efficacy is most strongly associated with adherence factors. This analysis indicates that patients with confidence in their abilities to follow treatment not only expect more positive consequences with adherence but also develop a better relationship with their health care providers (Gherman et al., 2011).

Bandura also identified the induction of self-efficacy through the individual's observation of other peers' performances (vicarious mode) coupled with the individual's self-judged efficacy assessment as a contributor to the individual's behavior (Bandura, 1992). Considering this induction, if Latinos with T2D observe and assess how other Latinos with T2D are dealing poorly with the disease, struggling or suffering from the long-term and complex care needs that T2D imposes on people, Bandura's concept of vicarious mode (causal contribution) of self-efficacy might be favoring a negative rather than positive effect over health behavior towards the management of T2D. Such an effect might also be exacerbated by the interaction of the perception constructs, particularly the perceived barriers. For example, if spoken language is considered a perceived barrier, then the Spanish-speaking individuals struggle with two language-based barriers, the barrier of speaking Spanish and the barrier of not speaking English. Language-based barriers are usually combined in terms of limited English proficiency (LEP) and non-English proficiency (NEP).

Latinos with LEP and that suffer from a chronic disease such as T2D must negotiate the difficulties of the services and information provided primarily in English, and usually through language-discordant interactions with health care providers. Parker et al. (2017) reported such an effect when the largest improvement in glycemic control was identified in LEP Latinos with diabetes switching from a language discordant health care provider (English-speaking primary care physician) to a language-concordant provider (Spanish-speaking primary care physician). Similarly, the language-discordant interactions between patients, family members, and providers are perceived as barriers to communication. These barriers cause a deleterious effect on the active, encouraging, and empowering patient-provider partnership in the diabetes self-management process (Aponte, Campos-Dominguez, & Jaramillo, 2015; Hu, Amirehsani, Wallace, & Letvak, 2013; Purnell et al., 2016).

As a theoretical framework, the HBM incorporates within its perception constructs certain factors that may help explain the health behavior of Latinos towards the diagnosis and disease management of T2D. The perceived barrier construct is perhaps the most inclusive of factors that both define the identity of Latinos and contribute to the chronic prevalence of T2D. Three factors represent these barriers primarily represented: Language, culture, and health literacy. Language and culture are intricately intertwined, and they can hardly be separated. Several authors agree that Latinos are a heterogeneous group that has common practices but that exhibit enough linguistic and cultural differences to avoid clustering them all together in one single group (Day et al., 2010; López et al., 2016; Mansyur, Rustveld, Nash, & & Jibaja-Weiss, 2016; Vega, Rodriguez, & Gruskin, 2009; Zsembik & Fennell, 2005).

The level of cultural influence by the U.S. culture in relation to their geographical proximity to the continental United States also verifies the heterogeneity of Spanish-speaking Latinos. This geographical proximity is the case of Caribbean Latinos from Puerto Rico and the Dominican Republic. Both groups show the highest prevalence of T2D, aside from Mexicans (18.1% for Puerto Ricans and Dominicans, and 18.3% for Mexicans), whereas South Americans showed a T2D prevalence of 10.2% (Schneiderman et al., 2014).

The health literacy factor is a complex barrier that may pass as general confusion to people, given that literacy goes beyond the capacity to read and write, as defined previously (IOM, 2004). Health literacy appears to be a tool of empowerment, providing opportunities for health promotion, health behavior, and social change (Velardo, 2015).

Although the specific components of health literacy remain in discussion, it appears that health literacy is a contributor, albeit limited, to racial/ethnic disparities; and a mediator of the relationship between educational attainment and health behavior (Friis, Lasgaard, Rowlands, Osborne, & Maindal, 2016; Velardo, 2015).

Another important perception construct, the perceived susceptibility, is potentially affected by the lack of understanding of the origin (causes) and management of T2D at three levels (Abraído-Lanza et al., 2016; Aponte, Campos-Dominguez, & Jaramillo, 2015; López et al., 2016). One, at the cultural level, the Spanish-speaking Latinos living in the continental United States go through an acculturation process that includes the incorporation of poor lifestyle and nutritional habits of the American diet with fast food, soft drinks (sodas), low vegetable intake, and reduced physical activity. That acculturation process may also be perceived as a sign of affluence (O'Brien, Alos, Davey, Bueno, & Whitaker, 2014). Two, at the genetic level, the incidence of T2D is mistakenly assumed as something that runs in the family (genetic inheritance). Two genes (HNF1A and) have been identified to have a causal effect, albeit minimal, to the onset of T2D in Mexicans (Estrada et al., 2014; Williams et al., 2014); and one gene for Puerto Ricans, PPARGC1A, in combination with low physical activity may partially explain the basis for the high prevalence of T2D in Puerto Ricans (Lai et al., 2008). Three, at the health level, there is no clear signal or symptom when T2D starts. If a person cannot recognize the onset of T2D as a health problem, then the lack of beliefs, and perceptions derived from the unrecognized onset of the disease may jeopardize the adoption of healthier behaviors that can lead to avoiding obesity and its physiological consequences.

Multiple studies addressing a variety of chronic diseases other than diabetes also report the use of the HBM extensively in health promotion and behavior change initiatives in the past decades (Harrison, Mullen, & Green, 1992; Janz & Becker, 1984; Kirscht, 1974), and in more recent times addressing diabetes and obesity (Gutierrez & Long, 2011; James, Pobee, Oxidine, Brown, & Joshi, 2012; McArthur, Riggs, Uribe, & Spaulding, 2018; Romano & Scott, 2014). Several international studies cite the HBM as their theoretical model for health promotion, health education, and behavior change initiatives. For example, China (Li et al., 2015), Hong Kong (Lo, Chair, & Lee, 2015), Indonesia (Andadari, Andarini, Sormarno, & Widjajanto, 2019), Iran (Farsi, Jabari-Moroui, & Ebadi, 2009; Hatamzadeh et al., 2017; Jalilian, Motlagh, Solhi, & Gharibnavaz, 2014; Karimy, Araban, Zareban, Taher, & Abedi, 2016; Shabibi et al., 2017; Sharifirad, Entezari, Kamram, & Azadbakht, 2009), Malaysia (Ahmad, 2014), Taiwan (Lin, Simoni, & Zemon, 2005), Turkey (Cenesiz & Atak, 2007; Yildirim, Avdal, & Ozgursoy Uran, 2018) and African countries (Ayele, Tesfa, Abebe, Tilahun, & Girma, 2012; Tamirat, Abebe, & Kirose, 2014). The importance of the availability of international studies, particularly the ones from Iran that focus on diabetes, indicate that the perceived benefits and barriers are related to self-care (self-efficacy) and that the HBM can be used as the framework to design lifestyle interventions for patients with diabetes with more effective results than other theory-based interventions (Doshmangir, Jahangiry, Farhangi, Doshmangir, & Faraji, 2018; Jalilian, Motlagh, Solhi, & Gharibnavaz, 2014; Karimy, Araban, Zareban, Taher, & Abedi, 2016; Mohebi, Azadbakht, Feizi, Sharifirad, & Kargar, 2013). The use of the HBM with Asian, Middle

Eastern, and African populations, show an international validity in the application of the HBM as a successful predictor of health behavior in populations that have been historically, genetically, and culturally related to Latino populations for centuries.

The Theory of Language Barriers

Throughout this dissertation study, the idea of language barriers as a barrier going beyond the pure communication aspect has been exposed using multiple factors that affect one's beliefs, perceptions, and ultimately behavior. Although the HBM helps explain the effects of these beliefs and perceptions in people's behavior, there is no reference to the wholesome effect of language as a barrier and how it can impact other areas past the communication aspect. A second theoretical framework is used to create a synergistic effect in explaining the language effect and how it can modify people's beliefs and perceptions that feel the effects of language as a barrier, people that we have been referring to as limited English proficient. This second theoretical framework is called The Theory of Language Barriers, and it was proposed by Glenn Martinez (Martinez G., 2010).

Martinez (2010) posits that the effect of the language barrier, in addition to blocking meaningful face-to-face communication in medical encounters, pervasively establishes "regimes of language" that structure uneven power relations between people that speak different languages. Although medical encounters are fundamental interactions, the effect of language barriers is not restricted to such encounters, but it is present throughout people's communities, making people with limited English proficiency (LEP) face significant challenges even before accessing health care. The LEP nature is unevenly distributed between the speakers (patient and health care provider), blocking the communication between them and the important intentional and unintentional transfer of meaning in their communication attempt. This lack of meaning due to the language discordance between the speakers usually prompts speakers to fill the gaps in communication with preconceived notions or rationalizations. Some of these notions or stereotypes may alter the perception of the speakers during their communication attempts. Although non-linguistic, this effect departs from the lack of meaning transfer, and consequently, poor understanding between the speakers.

Martinez (2010) posits that language barriers disproportionately affect minority populations through a gradient effect. This gradient effect shows that LEP speakers have worse health outcomes than bilinguals and that bilinguals have worse health outcomes than monolingual English speakers. This language-health gradient mirrors a different gradient that is well documented in the research literature, the wealth-health gradient (Bor, Cohen, & Galea, 2017).

The World Health Organization (2008) published the report from the Commission on Social Determinants of Health (CSDH), called Closing the Gap in a Generation. In this report, the CSDH provided three overarching recommendations: 1) Improve daily living conditions; 2) Tackle the inequitable distribution; and 3) Measure and understand the problem and assess the impact of the action (Commission on Social Determinants of Health, 2008). Bor, Cohen, and Galea (2017) describe that in the context of the rising levels of income inequality in the United States, there is a strong association between low income and health, expressed in shorter life expectancy for low-income people. The authors describe that some overarching factors widen the gaps in health outcomes, factors such as socioeconomic status and educational attainment.

As described in this chapter, H/L populations lag in both factors compared to other ethnic groups, weakening their positioning to climb the social ladder. The three overarching goals described by the CSDH could be directly applied to H/L populations to improve their overall social and health outcomes significantly. Marmot also described the connection between health and social standing through a social gradient or status gradient, with mechanisms that include relative social standing, social cohesion, and the ability to control one's life circumstances as the most important mechanisms (Marmot, 2004; 2006). This social/status gradient can be applied to H/L populations.

Martinez argues that the limited English proficiency of H/L populations positions them at a lower relative social standing in comparison to the dominant majority of monolingual English speakers. Although H/L residential segregation in urban areas in the United States is declining, such segregation still exists and contributes to the social isolation of H/L populations, not only at the residential level but also in the level of interaction with other ethnic groups (Iceland, Weinberg, & Hughes, 2014; Massey, 2016).

The third factor, a lack of control over one's circumstances, is the product of multiple internal and external factors described in this chapter. Language becomes, then, a barrier that transcends communication and draws a difficult pathway for H/L populations. Marmot (2018) describes the power dynamics between the mainstream population (English speakers) and those groups discriminated against because of ethnicity, gender, sexual orientation, migrant status, or disability. These factors may also explain the health inequalities in the United States and around the world (Marmot, 2018).

In the theory of language barriers, Martinez analyzes the causes of disease using a new epidemiological approach using language barriers and other social determinants of health (SDOH) as a classificatory schema to understand the disease origin and devise preventive measures (Martinez G. A., 2015a; Syme, 2009). Martinez defines four dimensions of language barriers. The barriers are barriers of interaction, barriers that ensure that health information is unevenly distributed, barriers of acceptance, and performance barriers. Martinez posits that these barriers provide explanatory power to the language barrier phenomenon.

Barriers of interaction. This barrier is the most recognizable. It is the barrier where the lack of a shared code of communication (language) cuts short the linguistic exchange and diminishes the addressivity of the speakers (interlocutors). The linguistic definition of addressivity is the interdependence of the interlocutors and their positioning as “oneself” and the “other,” interfering in the process of identity development through language (Bakhtin, 1986; Liaw & English, 2017). Diminishing addressivity makes the interlocutors socially invisible to each other, causing interaction barriers to conceal the personhood of patients and healthcare providers, potentially alienating patients from providers, and vice-versa. This alienation is not restricted to their direct interaction but also in other media formats such as print media, television, etc. (Liaw & English, 2017). Also, limited English proficiency tends to cluster H/L populations in tight social and neighborhood networks (Iceland, Weinberg, & Hughes, 2014).

Barriers that ensure that health information is unevenly distributed. This barrier is the result of the use of English as the primary language in the United States, even though no law determines the official language of the United States, only a bill that was introduced in 2003 and re-introduced in 2017 (Congress.Gov, n.d.; GovTrack, n.d.). The uneven distribution of information in English and not in Spanish and other languages is in contrast with the four-factor analysis that recipients (programs or agencies) of U.S. federal funds should be used to make documents readily available to non-English speaking populations, as described in *Title VI* of the Civil Rights Act and Executive Order 13166 (LEP.gov, 2018). The four factors include the number or proportion of LEP persons to be served, the frequency with which LEP individuals come in contact with the program, the nature, and importance of the program, and the resources available to the recipient, and the cost (LEP.gov, 2018). This uneven distribution of information barrier generates gaps in the availability and understandability of health information in LEP H/L populations, adding difficulties to their already complicated pathway to access health care. Although there are some attempts to decrease the uneven information barrier, the efforts are not systematic or systemic and are mostly reduced to face-to-face interactions using medical interpreters or teaching Spanish to healthcare professionals (Flores G., 2014; Martinez G. A., 2015b).

Barriers of acceptance. This barrier describes the blocking of intersubjectivity between the interlocutors impacting their mutual recognition of sameness. This blocking highlights the sociocultural differences instead. It contributes to a lack of authentication and acknowledgment of social identities between interlocutors and enhancing unconscious bias and stereotypes of lacking the willingness to adhere to treatment and providers' recommendations (Hall et al., 2015; James S. A., 2017; Rubin, Coles, & Barnett, 2016).

Performance barriers. This barrier is the product of the previous three barriers acting at the linguistic and psychosocial levels of LEP people. The performance barriers block people's intersubjective communication, interrupting their agency to implement health behaviors, and limiting their ability to take control of their disease management process. These limitations help explain the gaps in health care, and deepen the disconnection between the LEP patient's self-identity and their pathophysiology, widening the gap between LEP patients and the U.S. health system (Martinez G. , in press).

Articulating the Theoretical Frameworks

The use of the health belief model (HBM) and the theory of language barriers (TLB) in this dissertation is an attempt to address the behavioral (HBM) and psychosocial (TLB) aspects that H/L populations undergo while living with LEP in the United States. The concepts of the TLB's dimensions of language barriers overlap with the constructs of the HBM. The first three TLB barriers (interaction, uneven distribution of information, and acceptance) can be articulated with the HBM's four perception constructs (susceptibility, barriers, severity, and benefits), particularly with the interaction of the uneven distribution of information in English and the diminished addressivity (intersubjectivity) between patients (Spanish speakers) and healthcare providers (English speakers). The TLB's fourth dimension of the language barrier, the performance barriers, is related to the two newest HBM constructs, cues to action, and self-efficacy. The readiness to enact a behavior change (HBM) through cues to action (disease onset) is affected by the lack of understanding of the complexities of the origin, long-term care, and treatment of diabetes as a chronic disease, and consequently impacts the building of abilities and confidence to self-manage diabetes (Martinez G. , in press; Smith-Miller, Berry, DeWalt, & Miller, 2016; Thomas N. M., 2018).

Synergistic use of the HBM and TLB theories can help to predict behavior change under disparate conditions, where language, perceptions, and behavior intricately operate in people's lives, transcending communication, and that includes an acculturation process mediating the changing nature of people's self-identity. The scarce availability of research covering those factors enhances the difficulties that the H/L population with growing demographics and heterogeneous realities face in a society that largely ignores their needs by providing limited systematic interventions. The implications of social change are ample and overdue. This dissertation study is a quantitative approach to one of the most prevalent diseases (diabetes) in an understudied population (Puerto Ricans).

Summary

The extensive literature review in this study show four major themes. These themes, detailed below, describe the complexity of diabetes as a chronic disease. One, diabetes is more prevalent in ethnic and minority populations. Compared to whites, American Indian/Native Americans and H/L subpopulations are the most affected in the United States. Two, H/L populations show rates of diabetes prevalence in a gradient. This gradient encompasses country of origin, language acculturation, and length of stay in the

United States. H/L populations from the Caribbean countries (Puerto Rico, Dominican Republic) and the northern part of Latin America (Mexico) show the highest diabetes prevalence than any other Latin American country. Regarding LEP populations, the ones with lower language acculturation also seem to be the most affected with diabetes. Similarly, H/L populations with greater length of stay in the United States show higher diabetes prevalence and poorer disease management when they have stayed ten or more years in the United States.

Three, H/L populations have similar historical and cultural ties. However, they show heterogeneity in their chronic disease prevalence rates among themselves and when compared to White populations. Four, self-care behaviors are poorly understood among H/L populations. These behaviors mirror their heterogenous acculturation, socioeconomic status, and length of stay in the United States. This dissertation study is an attempt to identify and understand the potential effect of language acculturation in the proportion of people with diabetes and their self-care behaviors in adult Puerto Ricans as an underrepresented H/L population in a longitudinal epidemiological study. The quantitative analysis of longitudinal data of adult Puerto Ricans in the northeast of the United States helped shed light on this potential effect on their diabetes prevalence and self-care behaviors.

Chapter 3: Research Method

Introduction

The purpose of this study was to find out if language acculturation (preferred use of Spanish) among adult Puerto Ricans in the continental United States has an indirect effect on both prevalence and self-care behaviors of T2D. This research project was conducted using secondary data from the BPRHS. The BPRHS was a longitudinal study with a prospective examination of the role of psychosocial stress in the development of allostatic load (physiological dysregulation) to study the health disparities in 1,500 Puerto Rican adults from the Greater Boston area between 45 and 75 years of age (Tucker et al., 2010).

The BPRHS began in 2004 and involved five projects (Tucker et al., 2010). These projects involved work on multiple social, psychological, physiological, and cultural factors. Project I was a 5-year longitudinal prospective study on diet, vitamin status, and the risk of cardiovascular diseases in Puerto Ricans. Project II focused on the social and environmental context of cardiovascular risk in Puerto Ricans.

Project III was a genome-wide association study focused on cardiovascular health in elderly Puerto Ricans. Project IV was community-based participatory research on traffic pollution and cardiovascular diseases in Puerto Rican adults. Project V was a heart-healthy action program study for Puerto Rican adults. Throughout these projects, the BPRHS researchers produced a long list of variables that were used directly (single variable) or in combination (two or more variables) to conduct the statistical analyses that addressed the research questions of this dissertation study.

In this chapter, I describe the study methodology, design, and research questions. The chapter also includes a description of the eligibility criteria for the study population, variables, statistical methodology, and quantitative analysis plan to guide this investigation. The results from the statistical analysis of the dataset are presented in Chapter 4.

Research Design and Rationale

Methodology

In this study, I used quantitative, longitudinal analysis of secondary data to examine the effect of Spanish as the preferred spoken language on the prevalence rate and self-care behaviors of Puerto Rican adults with T2D. The prevalence of T2D and the presence of self-care behaviors in Puerto Ricans with T2D were examined by analyzing data from interviews using questionnaires with study participants at baseline, 2-year follow-up, and 5-year follow-up, anthropometric measures, and laboratory blood tests. Using a quantitative approach, I explored the relationship between T2D prevalence and language acculturation (preferred use of Spanish) with the potential to be associated with certain outcomes. In measuring the effect of a cause (factor *x*, spoken language) over outcomes (factor *y*, T2D prevalence), I considered three conditions between factors *x* and *y*: *x* must precede *y* in time, *x* must be correlated with *y* beyond chance, and the relation between *x* and *y* is not explained by other causes (Antonakis, Bendahan, Jacquart, & Lalive, 2010; Vanderstoep & Johnston, 2009).

Rationale

There is a high prevalence rate of T2D in H/L populations in the continental United States, but most of the data refer to H/L as a group or are primarily focused on Mexican Americans. There is a gap in the scientific literature addressing the longitudinal analysis of the primary spoken language and the prevalence of T2D in Puerto Rican adults in the continental United States. Therefore, a quantitative analysis of data from this subset of the H/L population (Puerto Rican adults) is essential to provide data on T2D, specifically concerning the Puerto Rican population.

Research Questions

The descriptive research question was as follows:

RQ1: What is the proportion of the adult population sample of Puerto Ricans living in the Boston metropolitan area that uses Spanish as their primary language?

The analytical research questions were as follows:

RQ2: Which factors contribute to the T2D prevalence in the adult population sample of Puerto Ricans living in the Boston metropolitan area that uses Spanish as their primary language?

RQ3: What is the relationship between language acculturation and T2D prevalence in the adult population sample of Puerto Ricans living in the Boston metropolitan area, after adjusting for potential confounders (age/gender/educational attainment/length of stay in the United States)?

RQ4: What is the relationship between language acculturation and diabetes self-care skills (healthy eating, being active, taking medication, and healthy coping) in Puerto Ricans living in the Boston metropolitan area, after adjusting for potential confounders (age/gender/educational attainment/length of stay in the United States)?

Hypotheses

Null Hypothesis 1 (H01): The preferred use of Spanish (language acculturation) in Puerto Ricans in the Boston metropolitan area has no relationship with diabetes prevalence rate.

Alternative Hypothesis 1 (HA1): The preferred use of Spanish (language acculturation) in Puerto Ricans in the Boston metropolitan area has a relationship with diabetes prevalence rate.

Null Hypothesis 2 (H02): The preferred use of Spanish (language acculturation) in Puerto Ricans in the Boston metropolitan area has no relationship with diabetes self-care skills.

Alternative Hypothesis 2 (HA2): The preferred use of Spanish (language acculturation) in Puerto Ricans in Boston has a relationship with T2D self-care behaviors.

Population

Sampling and Sampling Procedures

The BPRHS researchers used five methods to identify and recruit study participants, similar to other Latino-based studies (Eakin et al., 2007; Rodríguez, Rodriguez, & Davis, 2006). Tucker et al. (2010) described the following methods:

- The BPRHS researchers used data from the 2000 United States Census to identify census tracts with at least 25 Puerto Rican adults aged 45-75 years. From these, census blocks with at least 10 Puerto Rican adults were selected to conduct a minimum of three and a maximum of six household visits to identify one eligible adult.
- Participants were engaged randomly at events sponsored by community organizations.
- Participants were engaged through referrals.
- Participants were engaged through calls received from the distribution of flyers.
- Study information was disseminated using radio and television spots.

To meet eligibility criteria for the study, participants needed to be individuals 45-75 years of age who self-identified as being of Puerto Rican descent, were able to answer questions in English or Spanish and lived in the Boston, MA metropolitan area at the time of the study. After the initial screening contact, participants were scheduled to have an interview, with a reminder call up to 2 days before the interview, with up to five re-scheduling options, after which they were considered refusals. Of 2,084 eligible participants originally invited, 1,802 initially agreed to participate, and 1,500 completed the baseline interview (Tucker et al., 2010).

The BPRHS researchers conducted baseline interviews, and participants completed the baseline questionnaire between 2004 and 2009 (Tucker et al., 2010). There was a 2-year follow-up visit between 2006 and 2009 and a 5-year follow-up visit between 2009 and 2014 (Tucker et al., 2010). The baseline, 2-year follow-up, and 5-year follow-up questionnaires were administered in participants' households by bilingual interviewers. These bilingual interviewers were trained extensively to administer the questionnaires and perform anthropometric measures following procedures from other longitudinal studies such as the National Health and Nutrition Examination Survey (NHANES) II and III, the MacArthur Studies of Successful Aging, and the Hispanic Health and Nutrition Examination Survey (Chumlea et al., 1998; Delgado, Johnson, Roy, & Trevino, 1990; Dreon, John, DiCiccio, & Whittemore, 1993; McDowell et al., 1990; McDowell & Loria, 1989; Seeman et al., 1994). Tucker et al. (2010) did not report the assessment criteria used to identify BPRHS interviewers as "bilingual."

The general information collected by the BPRHS questionnaires included age, gender, primary language, education level, household income, migration, acculturation, employment history, family size, and food security. The study participants underwent extensive neuropsychological examinations to test their general and cognitive functions, including language (Artiola, Hermosillo, Heaton, & Pardee, 1999; Bermudez, Falcon, & Tucker, 2000; Karno, Burnam, Escobar, Hough, & Eaton, 1983; Lin, Bermudez, &

Tucker, 2003; Marin & Gamba, 1996). The language of preference was determined by the participant's ability to answer questions in Spanish or English.

Diabetes-specific and diabetes-related information collected by the BPRHS included the patient's self-reported diabetes diagnosis, fasting plasma glucose (and hemoglobin A1C), use of diabetes oral medication, and insulin. The BPRHS data included multiple specific and nonspecific diabetes management variables that were used in this study to match some of the AADE's seven diabetes management skills. These variables included the Healthy Eating Index at baseline (AADE 1: healthy eating), physical activity (AADE 2: being active), use of diabetes oral medications (AADE 4: taking medication), and heathy coping (AADE 7: healthy coping) and were used for statistical analysis (AADE, 2017).

Study Population

This dissertation study included 1,500 study participants who completed the BPRHS baseline questionnaire. For the 2-year follow-up, data from the 1,250 participants, which completed the BPRHS 2-year follow-up questionnaire were obtained. For the 5-year follow-up, data from the 961 participants, which completed the BPRHS 5-year follow-up questionnaire were obtained.

A power analysis (a priori) of the study sample for a two-tailed logistic regression analysis was conducted. The analysis indicated that 331 participants were needed, with an actual sample power of 0.8 using G*Power3 software (Heinrich Heine Universitat Dusseldorf, n.d.). The assumptions used included an 18% prevalence rate for Puerto

Ricans and an odds ratio of 1.5 based on the reported 50% greater chance for H/L to develop diabetes (CDC, 2019c; Schneiderman et al., 2014; see Appendix G).

Study Variables

All of the variables used in this dissertation study were obtained from the BPRHS. The BPRHS data were obtained using three questionnaires: baseline, 2-year follow-up, and 5-year follow-up. The three study stages were included in the statistical analyses.

Independent Variables

Demographic and Socioeconomic Variables

A codebook was obtained for each of the study stages with complete data available. The study stages included the following: baseline, 2-year follow-up, and 5-year follow-up. The demographic variables in Table 1 were drawn from the corresponding BPRHS codebook and represent the demographic and socioeconomic characteristics of the study participants.

The overall statistical analysis included a comparison of groups to address the longitudinal nature of the BPRHS study. This comparison included the three study stages (baseline, 2-year, and 5-year follow-up stages). The variables "language of interview" and "healthcare cost as a barrier" were analyzed based on their potential change over time to modify the statistical analysis from one group (study stage) to another, excluding participants who changed their language of interview or healthcare cost as a barrier status.

Table 1

Study Period and Participant's Demographic Variables

BPRHS stage	Variable	Determination or classification	Data note
Baseline, 2-year, and 5-year follow-up	Age	Age as an integer at baseline interview	
Baseline	Gender	Male, female	Female as the reference category
Baseline	Place of birth	Puerto Rico, Massachusetts, New York, New Jersey, Illinois, other	
Baseline	Father's place of birth	Puerto Rico, United States, other, don't remember, don't know	
Baseline	Mother's place of birth	Puerto Rico, United States, other, don't remember, don't know	
Baseline	Years since left Puerto Rico	Integer number	Measured in years
Baseline	Years in the United States	Integer number	Measured in years
Baseline	Years in Massachusetts	Integer number	Measured in years
Baseline	Education	No schooling or < 5^{th} grade, 5^{th}–8^{th} grade, 9^{th}–12^{th} grade or GED, some college or bachelor's, at least some graduate school	
Baseline, 2-year, and 5-year follow-up	Total household income	Income from employment, TANF, SSI, SSDI, child support, pension, retirement, food stamps, and other	
Baseline	Waist circumference	Measured in centimeters	
Baseline	BMI	Index between weight and height	

Note. TANF = Temporary Assistance for Needy Families; SSI = Supplemental Security Income; SSDI = Social Security Disability Insurance.
[a]Healthcare cost as a barrier is an overall variable, not diabetes specific.

Language Variables

Language variables were drawn from the corresponding BPRHS codebook questionnaire (baseline, 2-year follow-up, or 5-year follow-up). They represent the different variables describing the language characteristics of the study participants. The language variables in Table 2 were used to answer Research Question 1.

Table 2

Study Period and Participant's Language Variables

BPRHS stage	Variable	Determination or classification	Data note
Baseline	Native language	English, Spanish, other	--
Baseline	Language spoken	English, Spanish, other	Using "yes," "no," or "a little" for each language
Baseline	Reported use of language	Only English, only Spanish, mostly English, mostly Spanish, both the same	--
Baseline, 2-year follow-up	Language of cognitive interview*	English, Spanish	--
Baseline	Language of interview	English, Spanish, both English and Spanish	--

*The BPRHS participants underwent a neuropsychological examination after their interview. The variable "language of cognitive interview" captured the language used with the participant during the examination.

Acculturation Variables

Acculturation variables were drawn from the corresponding BPRHS codebook questionnaire (baseline, 2-year follow-up, or 5-year follow-up). They included the language acculturation score and the psychological acculturation score. The variables describe the acculturation characteristics of the study participants.

Table 3

Study Period and Participant's Acculturation Variables

BPRHS stage	Variable	Determination or classification	Data note
Baseline, 2-year and 5-year follow-up	Language acculturation scale[a]	English, Spanish, other	"0%" fully unacculturated, only Spanish; "100%" fully acculturated, fluent English
Baseline, 2-year and 5-year follow-up	Psychological acculturation scale[b]	Only with PR, more with PR than Americans, same among PR and Americans, more with Americans than PR, only with Americans	

Note. PR = Puerto Ricans.
[a]The BPRHS participants reported the use of language while watching TV, reading newspapers/books, speaking with neighbors, at work, listening to the radio, speaking with friends, speaking with family. See the formula in Appendix A. [b]The BPRHS participants answered the 10 questions of the Psychological Acculturation Scale (PAS) developed by Tropp, Erkut, Coll, Alarcon, and Garcia (1999) to understand their cultural preferences and with which group (either Puerto Ricans or Americans) they felt most comfortable with and best identified. See Appendix B.

Only the language acculturation variable was included in logistic regression analyses with the diabetes prevalence variable for each of the three study stages (see Table 4). Language acculturation was also used to conduct logistic regression analyses with four self-care skills variables (see Tables 5 to 8). The effect of time on language acculturation was measured using a paired sample t-test to see the changes between baseline and 2-year follow-up, 2-year follow-up and 5-year follow-up, and baseline and 5-year follow-up to address the longitudinal nature of the study.

Operationalization of Constructs

Dependent Variable 1: Prevalence of Diabetes

Two outcomes were analyzed in this dissertation study, the prevalence of diabetes and the skills to self-manage diabetes. Both outcomes were calculated using composite variables. The American Diabetes Association (ADA) criteria to determine the diagnosis of diabetes includes four criteria (ADA, 2018; 2019):

- Fasting blood (plasma) glucose (FPG) ≥ 126 mg/dL (7.0 mmol/L). (Fasting is defined as lack of caloric intake for a minimum of 8 hours), or
- Hemoglobin A1C ≥ 6.5% (48 mmol/mol), or
- 2-hour plasma glucose (PG) ≥ 200 mg/dL(11.1 mmol/mol) using 75 grams of anhydrous dissolved in water, as part of an oral glucose tolerance test (OGTT) (WHO Expert Committee on Diabetes Mellitus & World Health Organization, 1980); or
- Random PG ≥ 200 mg/dL in patients with classic hyperglycemia symptoms

The prevalence of diabetes at baseline was calculated using one criterion made up of two measurements, the combination of utilization of any of six anti-diabetic medications (metformin, insulin, meglitinides, sulfonylureas, glitazones, alpha-glucosidase inhibitors) or the blood measurement of hemoglobin A1C (glycosylated hemoglobin) is equal to or higher than 6.5% level following the current diabetes diagnosis criteria (ADA, 2018; 2019). The original BPRHS data considered a diabetes diagnosis when hemoglobin A1C was equal to or greater than 7%; however, since the BPRHS baseline time (2009), the diagnosis guidelines have been updated by the American Diabetes Association (ADA, 2018; 2019). The rationale to select this criterion is due to the wide time range that such criterion covers, 90 days, rather than a single snapshot of time if diagnosis criterion included fasting blood glucose test (ADA, 2018; 2019). See the BPRHS variable below.

Table 4

Study Period and Participant's Diabetes Prevalence Variables

BPRHS stage	Variable	Determination or classification
Baseline, 2-year, and 5-year follow-up[b]	Diabetes diagnosis with glycosylated hemoglobin and the use of anti-diabetic medication[a]	"1" If glycosylated hemoglobin≥6.5 or anti-diabetic medications are taken; "0" If glycosylated hemoglobin <6.5 and no anti-diabetic medications are taken

[a]See Appendix C for a description of the BPRHS variables used to determine diabetes prevalence with glycosylated hemoglobin and type of antidiabetic medications at baseline. [b]See Appendix D for a description of the BPRHS variables used to determine diabetes prevalence with glycosylated hemoglobin and type of antidiabetic medications at a 2-year follow-up and 5-year follow-up.

A change in the variable from Table 4 over time would indicate a new diagnosis, and the new prevalence would enter the subsequent analysis. The variable above was included in logistic regression analyses with the language variables (see Table 2).

Dependent Variable 2: Self-Care Behaviors

The BPRHS did not collect data that matched the AADE7's self-care behavior constructs of healthy eating, being active, monitoring, taking medication, problem-solving, reducing risks, and healthy coping. However, the list of BPRHS variables allowed building four AADE composite variables: healthy eating, being active, taking medication, and healthy coping (AADE, 2017).

Self-Care Skill 1: Healthy eating. The description of the Healthy eating construct is “Having diabetes does not mean you have to give up your favorite foods or stop eating in restaurants. In fact, there is nothing you cannot eat. But you need to know that the foods you eat affect your blood sugar.” A high HEI score (> 50) or resembling a more vegetarian or vegan diet were considered healthy eating as recent evidence indicates that a plant-based diet is capable of preventing and reversing T2D (Chowdhury, 2017; Mattei, McClain, Falcón, Noel, & Tucker, 2018; McMacken & Shah, 2017; Wright, Wilson, Smith, Duncan, & McHugh, 2017). This construct was part of the logistic regression analyses described in the analysis plan.

Table 5

Self-Care Skill 1 (Healthy Eating) Variable Components

BPRHS stage	Composite variable name	Category/range	Variable comment
Baseline	DIET_TYPE (type of diet, categorical variable)	“1” Kosher; “2” Vegetarian/Vegan; “3” Weight reduction; “4” Physician-prescribed diet.	It follows the U.S. Department of Agriculture’s guide to measuring household food security (Bickel, Nord, Price, Hamilton, & Cook, 2000).
2-year follow-up	DIET_TYPE_2YR (type of diet, categorical variable)	“1” Kosher; “2” Vegetarian/Vegan; “3” Weight reduction; “4” Physician-prescribed diet.	It follows the U.S. Department of Agriculture’s guide to measuring household food security (Bickel, Nord, Price, Hamilton, & Cook, 2000).
Baseline	HEI[a] (healthy eating index, continuous variable)	“0” unhealthy “100” healthiest	Nutritional assessment tool (U.S. DOA, 2019)

[a]The HEI is expected to be received with the BPRHS dataset.

Self-Care Skill 2: Being active. The description of the *being active* construct is "Being active, not just about losing weight. It has many health benefits like lowering cholesterol, improving blood pressure, lowering stress and anxiety, and improving your mood. If you have diabetes, physical activity can also help keep your blood sugar levels to normal and help you keep your diabetes in control." Following this construct, being active was defined as a high score (>30.0) in the BPRHS variable physical activity score described below and based on a previous BPRHS dataset study (Mattei, McClain, Falcón, Noel, & Tucker, 2018). This construct was part of the logistic regression analyses described in the analysis plan.

Table 6

Self-Care Skill 2 (Being Active) Variable Components

BPRHS stage	Composite variable name	Range
Baseline	PA_SCORE[a] (physical activity score at baseline, continuous variable)	"0" No physical activity; "≥50" Very physically active.
2-year follow-up	PA_SCORE_2YR[a] (physical activity score at 2-year follow-up, continuous variable)	"0" No physical activity; "≥50" Very physically active.
5-year follow-up	PA_SCORE_5YR[a] (physical activity score at 5-year follow-up, categorical variable)	"0" No physical activity; "≥50" Very physically active.

[a]The physical activity score calculations are detailed in Appendix E.

Self-Care Skill 3: Taking medication. The description of the Taking medication construct is, "There are several types of medications that are often recommended for people with diabetes. Insulin, pills that lower your blood sugar, aspirin, blood pressure medication, cholesterol-lowering medication, or a number of others may work together to lower your blood sugar levels, reduce your risk of complications and help you feel better." For this construct, participants' responses were analyzed for discrepancies between the reported "taking diabetes medication" and "taking any of six anti-diabetes medication." This construct was part of the logistic regression analyses described in the analysis plan.

Table 7

Self-Care Skill 3 (Taking Medication) Variable Components

BPRHS stage	Composite variable name	Categories
Baseline	MANTIDB[a] (taking any of six anti-diabetes medication, dichotomous variable)	"0" No "1" Yes
2-year follow-up	MANTIDB_2YR[a] (taking any of six anti-diabetes medication, dichotomous variable)	"0" No "1" Yes
5-year follow-up	MANTIDB_5YR[a] (taking any of six anti-diabetes medication, dichotomous variable)	"0" No "1" Yes

[a]Antidiabetes medications: metformin, insulin, meglitinides, sulfonylureas, glitazones, alpha-glucosidase inhibitors.

Self-Care Skill 4: Healthy coping. The description of the Healthy coping construct is, "Diabetes can affect you physically and emotionally. It is natural to have mixed feelings about your diabetes management and experience highs and lows. The important thing is to recognize these emotions as normal but take steps to reduce the negative impact they can have on your self-care." The variable perceived stress score was used to define healthy coping in participants reporting a low score (<25 out of 40) in the perceived stress score, as reported in a previous study using BPRHS data (Mattei, McClain, Falcón, Noel, & Tucker, 2018). As with the other self-care skills variables, *healthy coping* was analyzed using a group comparison approach between the BPRHS study stages. The cutoff value to recode *healthy coping* as a binary variable was determined at 28 after the BPRHS data set was received and analyzed.

Table 8

Self-Care Skill 4 (Healthy Coping) Variable Components

BPRHS stage	Composite variable name	Score range
Baseline	PSS[a] (perceived stress score, continuous variable)	0–56
2-year follow-up	PSS_2YR[a] (perceived stress score, continuous variable)	0–56
5-year follow-up	PSS_5YR[a] (perceived stress score, continuous variable)	0–56

[a]The perceived stress score questions and calculations are detailed in Appendix F.

Covariates

The BPRHS covariates used in the statistical analyses as confounders at baseline were *age*, *gender*, *educational attainment*, *length of stay in the United States*, and *length of stay in Massachusetts* (at baseline only). These covariates were selected for their frequent inclusion in diabetes publications as risk factors or associated with diabetes prevalence. A longer stay in the United States was used to analyze the effect of time spent in the United States as a proxy of overall acculturation with potential impact on diabetes prevalence and diabetes self-care behaviors of adult Puerto Ricans from the Boston Puerto Rican Health Study. The covariates were also tested against the independent variable (*language acculturation* score) and the dependent variables (*diabetes prevalence*, DV1; *healthy eating*, DV2; *being active*, DV3; *taking medication*, DV4; and *healthy coping*, DV5) to confirm their inclusion (see Table 9).

Table 9

Covariates: Migration History, Acculturation, and Perceived Stress at Baseline

BPRHS stage	Variable name	Definition	Range/reference
Baseline, 2-year and 5-year follow-up	Age	Age as an integer at baseline interview	45–81 years of age
Baseline	Gender	Male, female	Female as the reference category
Baseline	Educational attainment	No schooling or < 5^{th} grade, 5^{th}–8^{th} grade, 9^{th}–12^{th} grade or GED, some college or bachelor's, at least some graduate school	--
Baseline	Length of stay in the United States	Number of years in the United States	0–64 years

Data Access

The access to the Boston Puerto Rican Health Study dataset for non-investigative researchers involves the completion of an online Research Ethics and Compliance Training program designed by the Collaborative Institutional Training Initiative (CITI Program) (CITI, 2019), submission of the manuscript proposal, which describes the intended dissertation study, variables needed for the statistical analyses, and the research questions. The BPRHS Manuscript Proposal Form was completed and submitted for review to the University of Massachusetts Lowell's BPRHS Committee. A BPRHS investigator is required to participate in the completion of the research manuscripts involving any non-investigative researchers. For this study, one BPRHS investigator was included as coauthor of this research manuscript and the study's principal investigator. Additional coauthors included all the Walden University faculty serving on the dissertation committee.

Data Analysis

The University of Massachusetts at Lowell provided the BPRHS dataset. Upon approval of this proposal, a quantitative analysis of secondary data was used. The secondary data is anonymous and has undergone extensive cleaning, and has been used for numerous studies that are still being published as of the time of this dissertation study. Only a subset of the total list of variables from the BPRHS was used. SPSS version 24 statistical software was used to perform descriptive, trend, correlations, and multiple regression analyses.

Measures of central tendency (e.g., frequency, median, standard deviations) were calculated for the univariate distribution of all the BPRHS variables used in this study. The univariate distributions were stratified by age, gender, primary spoken language, and length of stay in the continental United States. The statistical analysis included a demographic profile of the Puerto Rican population in Boston with the total number of BPRHS participants, race and ethnicity, language spoken at home, language acculturation score, country of origin, and diabetes diagnosis. The goal of this dissertation study is to test the effect of the preferred use of Spanish (language acculturation) by Puerto Ricans in Boston and diabetes prevalence (using fasting serum glucose and hemoglobin A1c for the diagnosis) and self-management skills of diabetes.

Analysis Plan

Analysis 1. The first statistical analysis tested which variable was associated (odds ratio) with diabetes prevalence in adult Puerto Ricans in Boston. A logistic regression analysis was conducted with a composite (recalculated) variable combining glycosylated hemoglobin A1C and the use of anti-diabetic medication (see Table 4). The logistic regression analysis was conducted between *diabetes prevalence* (dependent variable 1, DV1) and *number of years in the United States, number of years in Massachusetts, waist circumference*, and *body mass index*.

Analysis 2. A bivariate logistic regression analysis was conducted to analyze the relationship (odds ratio) between the independent variable (*language acculturation* score, IV) and dependent variable 1 (*diabetes prevalence*) at each of the three study stages (baseline, 2-year follow-up, and 5-year follow-up). Additionally, a separate logistic regression analysis was conducted between *language acculturation score* and *diabetes prevalence,* adjusting for covariates to test other potential associations. The covariates included were *age*, *gender*, *educational attainment*, and *number of years in the United States*.

Analysis 3. Logistic regression analyses were conducted to assess the association (odds ratio) of the independent variable (*language acculturation score*) on four self-care skills in adult Puerto Ricans in Boston. The selected self-care skills were *healthy eating* (DV2), *being active* (DV3), *taking medication* (DV4), and *healthy coping* (DV5). Two sets of logistic regression analyses were conducted. One set included bivariate logistic regression analyses between *language acculturation score* (IV) and each self-care skill across the three study stages (baseline, 2-year follow-up, 5-year follow-up), except for *healthy eating* (DV2), which only included data from the baseline stage. The second set included a logistic regression analysis adjusting for confounders (*age*, *gender*, *educational attainment*, and *number of years in the United States*).

Analysis 4. A paired samples t-test was conducted to analyze the longitudinal effect of the data using the independent variable (*language acculturation score*, IV) across the three study stages (baseline, 2-year follow-up, 5-year follow-up). Pair 1: IV baseline and IV 2-year follow-up. Pair 2: IV 2-year follow-up and IV 5-year follow-up. Pair 3: IV baseline and IV 5-year follow-up.

Analysis 5. A paired samples t-test was conducted to analyze the longitudinal effect of diabetes prevalence (DV, dependent variable) across the three study stages (baseline, 2-year follow-up, 5-year follow-up), creating six pairs: Pair 1: DV baseline and DV 2-year follow-up. Pair 2: DV 2-year follow-up and DV 5-year follow-up. Pair 3: DV baseline and DV 5-year follow-up.

Goodness of fit. The binary logistic regression models used the Hosmer and Lemeshow Test as a goodness-of-fit measure. A non-significant value ($p > 0.05$) of the model's Hosmer and Lemeshow Test indicated that the model was a good fit of the model for the data set. The statistical models from the regression analyses were considered a good fit for the data and used to assess the hypotheses if the Hosmer-and Lemeshow test had a statistically significant value ($p < 0.05$), a Receiver Operating Curve (ROC) was conducted to verify that models had a value greater than 0.5 (see Appendix T).

Assumptions. As logistic regression is a nonparametric technique, there is no need for a linear relationship between the independent and dependent variables, and the normality and homoscedasticity (dependent variable's similar variance of values across a range of values for the independent variable) assumptions do not apply to it. In addition, the dependent variable (diabetes prevalence) is binary (proper coding), and the independent variable (language acculturation) is categorical. The BPRHS data set provided a large number of independent records to fit the requirements of the logistic regression model. Also, the measures of the predicting variables are independent, and as such, the independent variables do not need to be highly correlated with each other (Osborne, 2015).

Threats to Validity

Multiple factors can threaten the validity (internal and external) of inferences drawn from a study (Antonakis, Bendahan, Jacquart, & Lalive, 2010). Gauging the perception of this study depends on two main aspects. One, the ability of the study to answer hypothesized questions (internal validity). Two, the extent to which the results of the study may be generalized to other similar or different population groups (external validity) (Campbell, 1969).

This study included longitudinal data from a series of questionnaires conducted among a cohort of adult Puerto Ricans living in the Boston metropolitan area as part of the Boston Puerto Rican Health Study (BPRHS). Although the BPRHS involved the use of multiple recruitment strategies, the BPRHS or any other study is not devoid of potential flaws such as self-reporting bias, recall bias, and social desirability bias, particularly in surveys where questions ask for sensitive information such as diagnoses, use of drugs/medications, dietary patterns, and income (Althubaiti, 2016). The longitudinal nature of the BPRHS provides a plausible alternative to complex causal chains that are hardly achieved in public health studies because of the potential effect modification and losses to follow-up in populations undergoing randomized-controlled trials (Victora, Habicht, & Bryce, 2004).

Ethics

Multiple factors ensured that this dissertation did not violate the ethical principles of research with humans. First, the data was collected many years ago (between 2004 and 2009) using official federal and state-based census and demographic reports. Second, the data set that was provided by the BPRHS researchers is de-identified, maintaining the confidentiality of the study participants. Third, this data set has been used by multiple researchers over the years in dozens of peer-reviewed publications that did not reveal the identity of the study participants or caused any damage or injury to their well-being. Fourth, the author of this dissertation study and the statistical advisor were the only persons with access to the de-identified data provided by the BPRHS data set manager. The data was stored in an external hard drive with no access to the internet to minimize data exposure. The data was not destroyed as the BPRHS data set manager did not explicitly request it. The data set is intended to be used for subsequent studies after the dissertation study is concluded. The statistical analysis of the data provided opportunities to improve understanding of human behavior rather than affecting it. Therefore, I declare that this dissertation study did not violate any ethical principle in the study of human subjects and the handling of confidential data.

Summary

The secondary data set obtained from the BPRHS data set manager was analyzed using frequency distribution, measures of central tendency, and logistic regression analyses as the dependent variables (diabetes prevalence and self-care skills) are categorical. The dependent variable 1 (diabetes prevalence) was recalculated from its original conception using a value of glycosylated hemoglobin equal to or greater than 7% to a new value that concurs with the current diagnostic value equal to or greater to 6.5%. The statistical analysis entailed a comparison of groups, treating each of the three study stages as a group (baseline, 2-year, and 5-year follow-up).

Chapter 4: Results

Introduction

This chapter includes the results from the statistical analysis conducted with the BPRHS data set and presents how the data support the study research questions. Chapter 4 contains five subsections to explain the steps to manage and analyze the data. The subsections address (a) data retrieval, preparation, and calculation of composite variables; (b) the description of participants' demographics; (c) the descriptive analysis of data on the three study stages, and (d) the logistic regression analyses. All data management and statistical analyses were conducted using the Statistical Package for Social Sciences (SPSS) version 24 software (IBM, n.d.).

Data Retrieval, Preparation, and Calculation of Composite Variables

The BPRHS data set was acquired after the completion of two requirements. The first requirement was the submission and approval of a BPRHS Manuscript Proposal between June and July 2020. The second requirement involved a certificate from the Collaborative Institutional Training Initiative (CITI PROGRAM) that indicated the successful completion of five required modules and two elective modules (see Appendix H). The IRB application submission to Walden University's IRB resulted in conditional approval status. Once the principal investigator granted access to the data set, an updated submission to Walden University's IRB removed the conditional approval status of the dissertation study in August 2020 (IRB approval number 07-14-20-0493724).

Upon receipt, the data set was prepared to be uploaded into SPSS by importing the variables from each study stage provided (baseline, 2-year follow-up, and 5-year follow-up). Each study stage was imported to SPSS and subsequently merged into a single file. The values and names of variables were added to properly identify each variable during the calculation of composite variables and statistical analyses.

The descriptions of data set management and the need to calculate composite variables are useful to understand the results of the statistical analysis. Data management happened at four levels. First, the BPRHS researchers identified, collected, and delivered participants' data. Second, data cleaning and preparation of variables were conducted in SPSS with the data set delivered by the BPRHS data set manager to understand the data content and structure. Third, the calculation of composite variables followed a univariate analysis of frequency and value range (i.e., minimum and maximum values at the three study stages). Fourth, data were analyzed using frequency distribution, logistic regression, and paired samples *t*-test analyses.

Patient Identification and Delivery of Boston Puerto Rican Health Study Data

After receipt of the BPRHS data set variables, the number of patients included at each study stage was determined. The total numbers of participants included for this dissertation study were 1,506 participants ages 45-75 at baseline from May 2004 to October 2009; 1,258 participants ages 46-78 at the 2-year follow-up from June 2006 to June 2011; and 961 participants ages 49-81 at the 5-year follow-up from June 2011 to July 2015. The delivery of the data set involved a single Microsoft Excel file with 161 BPRHS variables.

Data Cleaning and Preparation of Variables

The BPRHS data set manager delivered the data following the study stages: baseline, 2-year follow-up, and 5-year follow-up. The BPRHS data set contains more than 500 variables. Out of those, the BPRHS data set manager delivered 161 variables for this dissertation study, and 25 variables were recalculated to prepare variables using an up-to-date diagnostic criterion (diabetes prevalence) and a combination of BPRHS variables to respond to the research questions.

For this study, diabetes prevalence (Dependent Variable 1 [DV1]), a new variable, was composed using two criteria. The first criterion included an updated diabetes diagnosis criterion where glycosylated hemoglobin equal to or greater than 6.5% was considered a diabetes diagnosis rather than previous diagnostic criteria that used 7.0% as the minimum threshold. The second criterion included the use of any of six antidiabetes medications (metformin, insulin, meglitinides, sulfonylureas, glitazones, alpha-glucosidase inhibitors). The combination of both criteria was applied to determine no diabetes prevalence (glycosylated hemoglobin less than 6.5% and no use of antidiabetes medication) and diabetes prevalence (glycosylated hemoglobin equal to or greater than 6.5% and both no use or use of any of six antidiabetes medications).

For healthy eating (Dependent Variable 2 [DV2]), the BPRHS dataset included the variable called Healthy Eating Index 2005 (HEI), an index that shows the type of healthy foods that participants eat. The HEI ranged from 0 to 100. Higher scores in the HEI-2005 indicate better diet quality. The operationalization of this variable involved converting the original HEI 2005 (continuous variable) into a binary variable (1: HEI <

72; 2: 72 ≤ HEI ≤ 100) to conduct a logistic regression analysis with the independent variable language acculturation score (IV) only at the baseline stage, as the HEI-2005 variable was only available at the baseline stage. The rationale to select the cutoff point at 72 was based on a previous study using the BPRHS data set and the median from the measures of central tendency (see Table 10).

Table 10

Measures of Central Tendency for the Variable Healthy Eating Index 2005 at Baseline

Healthy Eating Index (HEI) 2005		
N	Valid	1,483
	Missing	23
Mean		71.335
Median		72.260
Mode		75.880
Std. deviation		9.706
Variance		94.207
Minimum		30.570
Maximum		94.710

For being active (Dependent Variable 3 [DV3]), the BPRHS dataset included the variable called Physical Activity Score (pa_score), a sum of the physical activities that participants practiced. The pa_score ranged from 0 (*physically inactive*) to 100 (*very physically active*). The operationalization of this variable involved converting the original pa_score (continuous variable) into a binary variable to conduct a logistic regression analysis with the independent variable language acculturation score (IV) at the three study stages (baseline, 2-year follow-up, and 5-year follow-up). For the recoding of pa_score, the median for the corresponding study stage was selected as the cutoff point rounding up. At baseline, the cutoff was 30 (1: pa_score < 30; 2: 30 ≤ pa_score ≤ 100), the cutoff was 31 for the 2-year follow-up (1: pa_score < 31; 2: 31 ≤ pa_score ≤ 100), and the cutoff was 29 for the 5-year follow-up stage (1: pa_score < 29; 2: 29 ≤ pa_score ≤ 100; see Table 11).

Table 11

Measures of Central Tendency for the Variable Physical Activity Score (Being Active, DV3) at the Three Study Stages

		Baseline	2-year follow-up	5-year follow-up
N	Valid	1497	1254	956
	Missing	9	252	550
Mean		31.552	31.705	31.103
Median		30.400	30.578	28.770
Mode		29.100	27.000	27.400
Std. deviation		4.727	4.682	5.933
Variance		22.353	21.922	35.202
Minimum		24.300	24.450	24.500
Maximum		62.564	60.455	67.000

For taking medication (Dependent Variable 4 [DV4]), the BPRHS dataset included the binary variable called *taking any of six antidiabetic agents* (mantidb) with values that indicated if participants were not taking any of six antidiabetic agents (mantidbb = 0) or were taking any of six antidiabetic agents (mantidb = 1). Logistic regression analyses were conducted between taking any of six antidiabetic agents (mantidb) and the independent variable language acculturation score (IV) at the three study stages (baseline, 2-year follow-up, and 5-year follow-up).

For healthy coping (Dependent Variable 5, DV5), the BPRHS data set included the variable called perceived stress score (pss), a sum of the participants' feelings and thoughts during the last month. In Chapter 3, a cutoff from a publication using the BPRHS data set was 25 on a scale of 0 to 40 (reduced version of the scale). However, upon receipt of the BPRHS data set, the scale went from 0 (*without stress*) to 56 (*very stressed*) using a complete version of the scale. Additionally, the measures of central tendency for perceived stress score showed the mode at 28 in two of the three study stages (baseline and 5-year follow-up; see Table 11). Therefore, the operationalization of this variable involved recoding the original pss variable (continuous variable) into a binary variable to conduct a logistic regression analysis with the independent variable language acculturation score (IV) at the three study stages (baseline, 2-year follow-up, and 5-year follow-up). For the recoding of perceived stress score at baseline (1: $pss < 24$; 2: $24 \leq pss \leq 56$), at 2-year follow-up (1: $pss < 23$; 2: $23 \leq pss \leq 56$), and at 5-year follow-up (1: $pss < 27$; 2: $27 \leq pss \leq 56$), the median for the corresponding study stage was selected as the cutoff point (see Table 12). In this dissertation study, the values of perceived stress score are interpreted as inverse to healthy coping, with lower perceived stress interpreted as greater healthy coping skills.

Table 12

Measures of Central Tendency for the Variable Perceived Stress Score Across Study Stages

		Baseline	2-year follow-up	5-year follow-up
N	Valid	1,480	1,251	948
	Missing	26	255	558
Mean		23.66	22.89	27.00
Median		24.00	23.00	27.00
Mode		28	24	28
Std. deviation		9.412	8.758	7.262
Minimum		0	0	0
Maximum		56	50	52

Statistical Assumptions

The statistical analyses used in this dissertation, except the analysis to answer the first research question, included logistic regression analyses between language acculturation score (independent variable, IV) and binary variables (diabetes prevalence, DV1; healthy eating, DV2, being active, DV3; taking medication, DV4; and healthy coping, DV5). The statistical assumptions for a logistic regression analysis or logit model do not include a linear relationship between the independent variable and the dependent variable, and homoscedasticity or the assumption that the dependent variable shows similar amounts of variance across the values of the independent variable. The assumptions are reported in each logistic regression analysis.

Results

The BPRHS data set analysis in this dissertation study included frequency distributions of the following independent variables using frequency distribution and descriptive statistics at the baseline stage: gender, age, educational attainment, total household income, place of birth, and number of years in the United States. It also included logistic regression analyses between language acculturation score (independent variable, IV) and diabetes prevalence (Dependent Variable 1, DV1) at every study stage (baseline, 2-year follow-up, and 5-year follow-up). For the other dependent variables (self-care skills), logistic regression analyses were conducted between language acculturation score (IV) and each of the self-care skills: healthy eating (DV2, available at baseline only), being active (DV3, available at baseline, 2-year follow-up, and 5-year follow-up), taking medication (DV4, available at baseline, 2-year follow-up, and 5-year follow-up), and healthy coping (DV5, available at baseline, 2-year follow-up, and 5-year follow-up).

Demographics

The BPRHS study included 1,506 participants at baseline, 1,258 at the 2-year follow-up, and 961 at the 5-year follow-up. At baseline, the participants ranged from 45 years to 84 years of age. Table 13 shows a descriptive distribution of participants’ gender, age, educational attainment, total household income, place of birth, and number of years in the United States.

Table 13

Demographics of BPRHS Participants at Baseline

		Count	Percentage
Gender	Male	443	29.5%
	Female	1,059	70.5%
	Total	1,502[a]	100.0%
Age[b]	45 yrs to 64 yrs	1,208	80.4%
	65 yrs to 84 yrs	294	19.6%
	Total	1,502[a]	100.0%
Educational attainment	No schooling or less than 5th grade	321	21.5%
	5th–8th grade	375	25.1%
	9th–12th grade OR GED	571	38.2%
	Some college OR bachelor's degree	200	13.4%
	At least some graduate school	28	1.9%
	Total	1,495[a]	100.0%
Total household income[b]	$0 to $14,999	893	63.2%
	$15,000 to $29,999	354	25.1%
	$30,000 to $44,999	79	5.6%
	$45,000 to $59,999	30	2.1%
	$60,000 to $74,999	19	1.3%
	$75,000 to $89,999	21	1.5%
	$90,000 to $99,999	2	0.1%
	$100,000 and more	15	1.1%
	Total	1,413[a]	100.0%
Place of birth	Puerto Rico	1,440	96.2%
	Massachusetts	9	0.6%
	New York	36	2.4%
	New Jersey	2	0.1%
	Illinois	4	0.3%
	Other	6	0.4%
	Total	1,497[a]	100.0%
Years in the United States[b]	0 yrs to 10 yrs	80	5.4%
	11 yrs to 20 yrs	134	9.1%
	21 yrs to 30 yrs	229	15.6%
	31 yrs to 40 yrs	536	36.5%
	41 yrs to 50 yrs	398	27.1%
	51 yrs to 60 yrs	87	5.9%
	61 yrs to 70 yrs	5	0.3%
	Total	1,469[a]	100.0%

(*table continues*)

		Count	Percentage
Years in Massachusetts	0 yrs to 10 yrs	202	13.8%
	11 yrs to 20 yrs	243	16.6%
	21 yrs to 30 yrs	340	23.2%
	31 yrs to 40 yrs	494	33.7%
	41 yrs to 50 yrs	171	11.7%
	51 yrs to 60 yrs	17	1.2%
	Total	1,467[a]	100.0%
Waist circumference[b,c]	≤ 87.9 cm	246	16.6%
	≥ 88.0 cm	1,236	83.4%
	Total	1,482[a]	100.0%
BMI[b,d]	< 18.5 (underweight)	4	0.3%
	18.5 to 24.9 (normal/healthy weight)	192	13.0%
	25 to 29.99 (overweight)	447	30.2%
	30 to 34.99 (Obesity Class 1)	435	29.4%
	35 to 39.99 (Obesity Class 2)	234	15.8%
	40 or higher (Obesity Class 3)	170	11.5%
	Total	1,482[a]	100.0%

Note. *n* = 1,506. Total household income was calculated as including income from employment, social assistance, pensions, retirement, and other forms of income.
[a]Represents the total number of participants without missing data. [b]Variables were categorized on this table for display purposes, but they were analyzed as continuous variables in this dissertation study. [c]The cutoff for waist circumference (≥ 88 cm) is used based on publications identifying this cut off as abdominal adiposity for women (Meyer et al., 2016; Ross et al., 2020).[d]The categorical display of BMI followed the adult overweight and obesity classification by the Centers for Disease Control and Prevention (CDC, 2020a).

The BPRHS data set shows a large proportion of female participants (70.5%), with most participants between the ages of 45 and 64 years of age (80.4%). A majority of the participants (84.8%) reported education at the high school level, and a similar majority (88.3%) had a total household income lower than $30,000. Almost all participants were born in Puerto Rico (96.2%), with the majority of them having more than 20 years in the United States (85.4%) and in Massachusetts (69.8%). Similarly, BPRHS participants showed high values for factors associated with diabetes, such as waist circumference greater than 88 cm (83.4%) and overweight or obesity (86.9%).

Table 14 shows the frequency of diabetes prevalence of BPRHS participants across the three study stages. Diabetes prevalence was higher at the 2-year follow-up stage (51.0%) compared to baseline (50.4%) and the 5-year follow-up stage (50.0%). Overall, diabetes prevalence remained almost unchanged across the study stages.

Table 14

Diabetes Prevalence of BPRHS Participants Across the Three Study Stages

	Baseline[a]	2-year follow-up[a]	5-year follow-up[a]
No diabetes prevalence	722 (49.6%)	597 (49.0%)	422 (50.0%)
Diabetes prevalence	735 (50.4%)	622 (51.0%)	422 (50.0%)

[a]Valid percentage calculated, excluding missing data.

Research Question 1

To analyze the first research question (RQ1: What is the proportion of the adult population sample of Puerto Ricans living in the Boston metropolitan area that uses Spanish as their primary language?), a descriptive statistics comparison was conducted using four variables: native language, most spoken language, language of interview, and language acculturation score. The reported native language was Spanish for 96.3% (n = 1,439) of participants, with 74.5% (n = 1,104) of participants speaking only Spanish or mostly Spanish. Compared to the reported native English language 3.2% (n = 48), the use of English as the language of interview increased to 3.9% (n = 59), whereas 86.2% (n = 1,291) of participants used Spanish as the language of interview and 9.8% (n = 147) of participants used both languages. The use of two languages during the interview favors the use of English, and it showed an increase of 0.7% (*n* = 11), compared to a decrease in the use of Spanish of 10.1% (*n* = 148). The language acculturation score shows a similar distribution with 80.9% (*n* = 1,211) speaking only Spanish or mostly Spanish, with 16.2% (*n* = 242) speaking more English than Spanish, and only 2.9% (*n* = 43) speaking mostly English or only English (see Table 15).

Table 15

BPRHS Variables That Capture Participants' Language at Baseline

		Count	Percentage
What is your native language?	English	48	3.2%
	Spanish	1,439	96.3%
	Other	8	0.5%
Speak mostly which language?	Only English	6	0.4%
	Only Spanish	535	36.1%
	Mostly English	89	6.0%
	Mostly Spanish	569	38.4%
	Both the same	283	19.1%
Language of interview	English	59	3.9%
	Spanish	1,291	86.2%
	Both English and Spanish	147	9.8%
Language acculturation score[a]	0 to 24.99% (mostly Spanish)	798	53.3%
	25.00% to 49.99%	413	27.6%
	50.00% to 74.99%	242	16.2%
	75.00% to 100% (mostly English)	43	2.9%

[a]Variables were categorized on this table for display purposes, but they were analyzed as continuous variables in this dissertation study.

The measures of central tendency of *language acculturation score* show variation from one study stage to the next. There was a decrease in the number of participants from one study stage to the next (1,496 to 1,255 to 954), a decrease in the mean (24.402 to 22.989 to 20.870), and the median (20.833 to 16.666 to 12.500). The reduction in the number of participants from baseline to 2-year follow-up and 2-year follow-up to 5-year follow-up and a possible resorting to the use of the native Spanish language (low acculturation score) with aging may contribute to the changes in the mean and median changes across the study stages. The mode (.000) and range (.000 to 93.85) remained unchanged (see Table 16).

Table 16

Measures of Central Tendency for the Language Acculturation Score and Age Variables Across the Study Stages

		Language acculturation score			Age		
		Baseline	2-year follow-up	5-year follow-up	Baseline	2-year follow-up	5-year follow-up
N	Valid	1,496	1,255	954	1,502	1,258	961
	Missing	10	251	552	4	248	545
Mean		24.402	22.989	20.870	57.06	59.26	63.00
Median		20.833	16.666	12.500	56.00	58.00	62.00
Mode		.000	.000	.000	50	54	59
Std. deviation		22.519	22.282	22.913	7.598	7.667	7.653
Variance		507.146	496.501	525.014	57.725	58.780	58.564
Minimum		.000	.000	.000	45	46	49
Maximum		95.833	95.833	95.830	75	78	81

Paired samples *t*-test of language acculturation score across three study stages. To investigate if there was a change in the language acculturation scores of the study participants, multiple paired samples *t*-tests were conducted using three pairs: Baseline to 2-year follow-up (pair 1), 2-year follow-up to 5-year follow-up (pair 2), and from baseline to 5-year follow-up (pair 3). For pair 1, the results of the paired samples *t*-test showed the mean difference of language acculturation score of participants after 2 years [*Mean* difference = 1.295, *SD* = 15.363, *95% C.I.* (.443, 2.146)] was statistically significant at the .05 level of significance (*t* = 2.984, *df* = 1252, *p* < .05). For pair 2, the results of the paired samples *t*-test showed the mean difference of language acculturation score of participants after 2 years [*Mean* difference = 1.311, *SD* = 15.878, *95% C.I.* (.283, 2.338)] was statistically significant at the .05 level of significance (*t* = 2.505, *df* = 919, *p* < .05). Similarly, for pair 3, the results of the paired samples *t*-test showed the mean difference of language acculturation score of participants after five years [*Mean* difference = 2.533, *SD* = 15.766, *95% C.I.* (1.529, 3.537)] was statistically significant at the .001 level of significance (*t* = 4.951, *df* = 948, *p* < .001). These findings indicate a statistically significant change in the language acculturation scores of the study participants from baseline to 2-year follow-up to 5-year follow-up. This finding suggests that the language acculturation score decrease over time in the study participants is statistically significant, indicating that the participants were more likely to speak Spanish during the follow-up study stages (see Table 17).

Table 17

Paired Samples t-Test to Compare Language Acculturation Score Across the Study Stages

	Language acculturation score	Mean	Std. deviation	95% confidence interval of the difference		*t*	Sig. (2-tailed)
				Lower	Upper		
Pair 1	Baseline– 2-year follow-up	1.295	15.363	.443	2.146	2.984	.003
Pair 2	2-year follow-up– 5-year follow-up	1.311	15.878	.283	2.338	2.505	.012
Pair 3	Baseline– 5-year follow-up	2.533	15.766	1.529	3.537	4.951	< .001

Paired samples *t*-test: Diabetes prevalence across three study stages. As with language acculturation score, to investigate if there was a change in the diabetes prevalence of the study participants, multiple paired samples *t*-tests were conducted using three pairs: baseline to 2-year follow-up (pair 1), 2-year follow-up to 5-year follow-up (pair 2), and from baseline to 5-year follow-up (pair 3). For pair 1, the results of the paired samples *t*-test showed the mean difference of diabetes prevalence of participants after 2 years [*Mean* difference = -.008, *SD* = .386, *95% C.I.* (-.030, .014)] was not statistically significant at the .05 level of significance (t = -.794, df = 1197, p > .05). For pair 2, the results of the paired samples *t*-test showed the mean difference of diabetes prevalence of participants after 2 years [*Mean* difference = .005, *SD* = .387, *95% C.I.* (-.022, .032)] was not statistically significant at the .05 level of significance (t = .365, df = 801, p > .05). Similarly, for pair 3, the results of the paired samples *t*-test showed the mean difference of language acculturation score of participants after 5 years [*Mean* difference = -.013, *SD* = .420, *95% C.I.* (-.042, .015)] was not statistically significant at the .05 level of significance (t = -.913. df = 823, p > .05). These findings indicate that there is not a statistically significant change in the diabetes prevalence of the study participants from baseline to 2-year follow-up to 5-year follow-up. This finding suggests that diabetes prevalence does not show a statistically significant difference over time in the study participants, showing that diabetes prevalence remained mostly high and stable (see Table 18).

Table 18

Paired Samples t-Test to Compare Diabetes Prevalence Across the Study Stages

	Diabetes prevalence	Mean	Std. deviation	95% confidence interval of the difference		*t*	Sig. (2-tailed)
				Lower	Upper		
Pair 1	Baseline–2-year follow-up	-.008	.386	.011	.014	-.749	.454
Pair 2	2-year follow-up–5-year follow-up	1.005	.387	.014	.032	.365	.715
Pair 3	Baseline–5-year follow-up	-.013	.420	.015	.015	-.913	.361

Research Question 2

To answer the second research question (RQ2: Which factors contribute to the type 2 diabetes prevalence in the adult population sample of Puerto Ricans living in the Boston metropolitan area that uses Spanish as their primary language?), bivariate logistic regression analyses were conducted between diabetes prevalence (DV1) and four contributing factors (predictor variables): number of years in the United States, number of years in Massachusetts, waist circumference, and BMI. Bivariate logistic regression analyses were conducted between diabetes prevalence and each of the four contributing factors at baseline, where information was available for all four contributing factors. Additionally, bivariate logistic regression analyses were conducted between diabetes prevalence and waist circumference and BMI, the only contributing factors with data available at the 2-year and 5-year follow-up study stages.

At baseline, in the first bivariate logistic regression analysis, number of years in the United States was found to contribute to the model. The unstandardized Beta weight for the predictor variable: *B* = (.012), *SE* = .004, *Wald* = 8.117, $p < .05$. The estimated odds ratio showed an increase of 1.2% [*Exp(B)* = 1.012, 95% C.I. (1.004, 1.021)] for diabetes prevalence for every one unit increase of number of years in the United States. In the second bivariate logistic regression analysis, number of years in Massachusetts was found to contribute to the model. The unstandardized Beta weight for the predictor variable: *B* = (.013), *SE* = .004, *Wald* = 9.142, $p < .05$. The estimated odds ratio showed an increase of 1.3% [*Exp(B)* = 1.013, 95% C.I. (1.004, 1.021)] for diabetes prevalence for every one unit increase of number of years in Massachusetts. In the third bivariate logistic regression analysis, waist circumference was found to contribute to the model. The unstandardized Beta weight for the predictor variable: *B* = (.037), *SE* = .004, *Wald* = 84.197, $p < .001$. The estimated odds ratio showed an increase of nearly 4.0% [*Exp(B)* = 1.037, 95% C.I. (1.029, 1.046)] for diabetes prevalence for every one unit increase of waist circumference. In the fourth bivariate logistic regression analysis, BMI was found to contribute to the model. The unstandardized Beta weight for the predictor variable: *B* = (.065), *SE* = .009, *Wald* = 56.667, $p < .001$. The estimated odds ratio showed an increase of nearly 7.0% [*Exp(B)* = 1.067, 95% C.I. (1.049, 1.085)] for diabetes prevalence for every one unit increase of BMI (see Table 19).

At the 2-year follow-up stage, a bivariate logistic regression analysis between diabetes prevalence and waist circumference was conducted. The predicting variable, waist circumference, was tested a priori to verify there was no violation of the assumption of the linearity of the logit. In the logistic regression analysis, the predictor variable, waist circumference, was found to contribute to the model. The unstandardized

Beta weight for the Constant; *B* = (-3.470), *SE* = .459, *Wald* = 57.154, $p < .001$. The unstandardized Beta weight for the predictor variable: *B = .034, SE* = .004, *Wald* = 58.835, $p < .001$. The estimated odds ratio showed an increase of 3.4% [*Exp(B)* = 1.034, 95% C.I. (1.026, 1.043)] for diabetes prevalence for every one unit increase of waist circumference. A bivariate logistic regression analysis between diabetes prevalence and BMI was conducted. The predicting variable, BMI, was tested a priori to verify there was no violation of the assumption of the linearity of the logit. In the logistic regression analysis, the predictor variable, BMI, was found to contribute to the model. The unstandardized Beta weight for the Constant; *B* = (-1.871), *SE* = .303, *Wald* = 38.233, $p < .001$. The unstandardized Beta weight for the predictor variable: *B = .060*, *SE* = .009, *Wald* = 40.315, $p < .001$. The estimated odds ratio showed an increase of 6.1% [*Exp(B)* = 1.061, 95% C.I. (1.042, 1.081)] for diabetes prevalence for every one unit increase of BMI.

At the 5-year follow-up stage, a bivariate logistic regression analysis between diabetes prevalence and waist circumference was conducted. The predicting variable, waist circumference, was tested a priori to verify there was no violation of the assumption of the linearity of the logit. In the logistic regression analysis, the predictor variable, waist circumference, was found to contribute to the model. The unstandardized Beta weight for the Constant; *B* = (-1.944), *SE* = .499, *Wald* = 15.174, $p < .001$. The unstandardized Beta weight for the predictor variable: *B = .018, SE* = .005, *Wald* = 14.781, $p < .001$. The estimated odds ratio showed an increase of nearly 2.0% [*Exp(B)* = 1.019, 95% C.I. (1.009, 1.028)] for diabetes prevalence for every one unit increase of waist circumference. A bivariate logistic regression analysis between diabetes prevalence and BMI was conducted. The predicting variable, BMI, was tested a priori to verify there was no violation of the assumption of the linearity of the logit. In the logistic regression analysis, the predictor variable, BMI, was found to contribute to the model. The unstandardized Beta weight for the Constant; B = (-1.570), SE = .374, $Wald$ = 17.577, $p <$ .001. The unstandardized Beta weight for the predictor variable: $B = .049$, SE = .012, $Wald$ = 17.161, $p < .001$. The estimated odds ratio showed an increase of 5.0% [$Exp(B)$ = 1.050, 95% C.I. (1.026, 1.075)] for diabetes prevalence for every one unit increase of BMI (see Table 19).

Table 19

Bivariate Logistic Regression Analyses Between Diabetes Prevalence (DV1) and Individual Contributing Factors Across Study Stages

	Baseline				2-year follow-up				5-year follow-up			
			95% CI for *OR*				95% CI for *OR*				95% CI for *OR*	
Contributing factor	Sig.	*OR*	Lower	Upper	Sig.	*OR*	Lower	Upper	Sig.	*OR*	Lower	Upper
Number of years in the United States	.004	1.012	1.004	1.021	--	--	--	--	--	--	--	--
Number of years in Massachu-setts	.002	1.013	1.004	1.021	--	--	--	--	--	--	--	--
Waist circumfer-ence	< .001	1.037	1.029	1.046	< .001	1.034	1.026	1.043	< .001	1.019	1.009	1.028
BMI	< .001	1.067	1.049	1.085	< .001	1.061	1.042	1.081	< .001	1.050	1.026	1.075

Since the length of stay in the United States and length of stay in Massachusetts were almost identical, the covariate number of years in the United States was used as a proxy for length of stay in the United States in the logistic regression analyses between the independent variable (*language acculturation score*) and the five dependent variables (*diabetes prevalence, healthy eating, being active, taking medication*, and *healthy coping*).

Research Question 3

To answer research question 3 (RQ3: What is the relationship between language acculturation and type 2 diabetes prevalence in the adult population sample of Puerto Ricans living in the Boston metropolitan area, after adjusting for potential confounders (age/gender/educational attainment/length of stay in the United States)?), bivariate logistic regression analyses were conducted between language acculturation score (IV) and diabetes prevalence (DV1) to check for an individual association. The logistic regression analyses were conducted for the three study stages (baseline, 2-year follow-up, and 5-year follow-up). In each study stage, language acculturation score proved to have a statistically significant association with diabetes prevalence (see Table 20).

Table 20

Odds Ratios From Bivariate Logistic Regression Analyses Between Language Acculturation Score (IV) and Diabetes Prevalence (DV1) at the Three Study Stages

			95% CI for *OR*	
	Sig.	*OR*	Lower	Upper
Baseline	< .001	.990	.985	.994
2-year follow-up	< .001	.989	.984	.994
5-year follow-up	.007	.992	.986	.998

At the BPRHS baseline stage, a logistic regression between language acculturation score (IV) and diabetes prevalence (DV1) was conducted. The predicting variable, language acculturation score, was tested a priori to verify there was no violation of the assumption of the linearity of the logit. In the logistic regression analysis, the predictor variable, language acculturation score, was found to contribute to the model. The unstandardized Beta weight for the Constant; *B* = (.272), *SE* = .078, *Wald* = 12.141, $p < .001$. The unstandardized Beta weight for the predictor variable: *B = -.010, SE =* .002, *Wald* = 19.584, $p < .001$. The estimated odds ratio showed a decrease of 1.0% [*Exp(B)* = .990, 95% C.I. (.985, .994)] for diabetes prevalence for every one unit increase of language acculturation score.

At the BPRHS 2-year follow-up, the logistic regression between language acculturation score (IV) and diabetes prevalence (DV1) was conducted. The predicting variable, language acculturation score, was tested a priori to verify there was no violation of the assumption of the linearity of the logit. In the logistic regression analysis, the predictor variable, language acculturation score, was found to contribute to the model. The unstandardized Beta weight for the Constant; *B* = (.291), *SE* = .083, *Wald* = 12.219, $p < .001$. The unstandardized Beta weight for the predictor variable: *B = -.011, SE =* .003, *Wald* = 17.206, $p < .001$. The estimated odds ratio showed a decrease of 1.1% [*Exp(B)* = .989, 95% C.I. (.984, .994)] for diabetes prevalence for every one unit increase of language acculturation score.

At the BPRHS 5-year follow-up, the logistic regression between language acculturation score (IV) and diabetes prevalence (DV1) was conducted. The predicting variable, language acculturation score, was tested a priori to verify there was no violation of the assumption of the linearity of the logit. In the logistic regression analysis, the predictor variable, language acculturation score, was found to contribute to the model. The unstandardized Beta weight for the Constant; *B* = (.169), *SE* = .094, *Wald* = 3.253, *p* > .05. The unstandardized Beta weight for the predictor variable: *B = -.008, SE* = .003, *Wald* = 7.272, *p* < .05. The estimated odds ratio showed a decrease of nearly 1.0% [*Exp(B)* = .992, 95% C.I. (.986, .998)] for diabetes prevalence for every one unit increase of language acculturation score (see Table 20).

The variables age, gender, educational attainment, and number of years in the United States were included as confounders after verifying an independent relationship with the dependent variable (diabetes prevalence) or the independent variable (language acculturation score). A logistic regression analysis was conducted between language acculturation score (IV) and diabetes prevalence (DV1), adjusting for age, gender, educational attainment, and length of stay in the United States as confounders. The Hosmer-Lemeshow goodness-of-fit was not significant (*p* > .05), indicating the model is correctly specified. Additionally, the *-2 log Likelihood* = 1900.454 and the *Nagelkerke R squared* = .071. The model resulted in the independent variables, gender, educational attainment, and number of years in the United States not significant (*p* > .05). However, the independent variable age was found to be significant (*p* < .001), and the independent variable language acculturation score was also found to be significant (*p* < .05). Controlling for gender, educational attainment, and number of years in the United States, the predictor variables, age, and language acculturation score, in the logistic regression analysis were found to contribute to the model. For age, the unstandardized *B* = .050, *SE* = .008, *Wald* = 35.929, *p* < .001. The estimated odds ratio showed a *positive* relationship of 5.1% increase [*Exp (B)* = 1.051], 95% CI (1.034, 1.069)] for every one year increase of *age*. For language acculturation score, the unstandardized B = -.007, SE = .003, *Wald* = 5.039, $p < .05$. The estimated odds ratio showed a *negative* relationship of nearly 1.0% decrease [*Exp (B)* =.993], 95% CI (.987, .999)] for every one unit increase of language acculturation score (see Table 21).

Table 21

Logistic Regression Analysis Between Language Acculturation Score (IV) and Diabetes Prevalence (DV1) Adjusting for Confounders at Baseline Stage

			95% CI for *OR*	
	Sig.	*OR*	Lower	Upper
Age	< .001	1.051	1.034	1.069
Male gender[a]	.817	1.029	0.810	1.306
No schooling or less than 5th grade	.217	1.706	0.731	3.980
5th–8th grade	.283	1.580	0.686	3.640
9th–12th grade	.315	1.518	0.672	3.429
Some college OR bachelor's degree	.127	1.924	0.830	4.458
At least some graduate school[b]	.465	--	--	--
Years in the United States	.075	1.009	0.999	1.019
Language acculturation score	.025	0.993	0.987	0.999

[a]The reference group for the gender category was “Female.” [b]The reference group for the educational attainment category was “At least some graduate school.”

The confounding variable age was the only confounder showing a statistically significant association with diabetes prevalence. Notwithstanding, even after adjusting for confounders, including age, the association between language acculturation score and diabetes prevalence remained a statistically significant association.

Research Question 4

To answer the fourth research question (RQ4: What is the relationship between language acculturation and diabetes self-care skills (healthy eating, being active, taking medication, and healthy coping) in Puerto Ricans living in the Boston metropolitan area, after adjusting for potential confounders (age/gender/educational attainment/length of stay in the United States)?) there were two sets of analyses. The first set included the independent variable (language acculturation score) being tested against each of the self-care skills (dependent variables 2 to 5: healthy eating, being active, taking medication, and healthy coping) across the three study stages (baseline, 2-year follow-up and 5-year follow-up), except for healthy eating that was tested only at baseline because Healthy Eating Index 2005, the BPRHS variable used as healthy eating was only available at the baseline stage. The second set of analyses included bivariate logistic regression analyses conducted between the self-care skills (dependent variables 2 to 4: healthy eating, being active, taking medication, and healthy coping) across the three study stages (baseline, 2-year follow-up, and 5-year follow-up) and potential confounders. For healthy eating, the logistic regression analysis with confounders only included the baseline stage for the same reason mentioned above.

Logistic regression analyses: Language acculturation score and Healthy Eating Index 2005 (healthy eating). A logistic regression analysis was conducted between language acculturation score (IV) and healthy eating (DV2) to analyze the relationship with language acculturation score independent from confounders at baseline only as data from the Healthy Eating Index 2005 was only available for that study stage. The predicting variable, language acculturation score, was tested a priori to verify there was no violation of the assumption of the linearity of the logit. In the logistic regression analysis, the predictor variable, language acculturation score, was found to contribute to the model. The unstandardized Beta weight for the Constant; *B* = (.367), *SE* = .078, *Wald* = 22.200, $p < .001$. The unstandardized Beta weight for the predictor variable: *B* = -.012, *SE* = .002, *Wald* = 27.927, $p < .001$. The estimated odds ratio showed a decrease of 1.2% [*Exp(B)* = .988, 95% C.I. (.983, .992)] for healthy eating for every one unit increase of language acculturation score (see Table 22).

Table 22

Bivariate Logistic Regression Analysis Between Language Acculturation Score (IV) and Healthy Eating (DV2) at Baseline Stage

			95% CI for *OR*	
	Sig.	*OR*	Lower	Upper
Baseline	< .001	.988	.983	.992

The variables age, gender, educational attainment, and number of years in the United States were included as confounders after verifying an independent relationship with the dependent variable (healthy eating) or the independent variable (language acculturation score). A logistic regression analysis was conducted between language acculturation score (IV) and Healthy Eating Index 2005 (healthy eating, DV1), adjusting for age, gender, educational attainment, and number of years in the United States as confounders. The Hosmer-Lemeshow goodness-of-fit was not significant ($p > .05$), indicating the model is correctly specified. Additionally, the *-2 log Likelihood* = 1875.573 and the *Nagelkerke R squared* = .114. The model resulted in the independent variables educational attainment (only in one category, some college or bachelor's degree), number of years in the United States, and language acculturation score not significant ($p > .05$). Although not significant (p =.051), the language acculturation score showed a borderline statistically significant contribution to the model. However, the independent variable *age* was found to be significant ($p < .001$), the independent variable gender was found to be significant ($p <.001$), and the independent variable educational attainment (in three of its categories, No schooling or less than 5th grade, 5th – 8th grade, and 9th – 12th grade or GED) was found to be significant. Controlling for number of years in the United States and language acculturation score, the predictor variables, age, gender, and educational attainment, in the logistic regression analysis were found to contribute to the model. For age, the unstandardized $B = .061$, $SE = .009$, $Wald = 49.896$, $p < .001$. The estimated odds ratio showed a *positive* relationship of 6.3% increase [*Exp (B)* = 1.063], 95% CI (1.045, 1.081)] for every one year increase of age. For gender, the unstandardized $B = -.792$, $SE = .124$, $Wald = 41.033$, $p < .001$. The estimated odds ratio showed a *decrease* of nearly 55.0% [*Exp (B)* =.453], 95% CI (.355, .577)] for males compared to females. For the “No schooling or less than 5th grade” category of educational attainment, the unstandardized $B = -1.094$, $SE = .454$, $Wald = 5.800$, $p < .05$. The estimated odds ratio showed a *negative* relationship of nearly 67.0% decrease [*Exp (B)* = .335], 95% CI (.137, .816)] for every one unit increase of educational attainment. For the “5th – 8th grade” category of educational attainment, the unstandardized $B = -.940$, $SE = .447$, $Wald = 4.420$, $p < .05$. The estimated odds ratio showed a *negative* relationship of nearly 61.0% decrease [*Exp (B)* = .391], 95% CI (.163, .938)] for every one unit increase of educational attainment. For the “9th – 12th grade” category of educational attainment, the unstandardized $B = -.976$, $SE = .436$, $Wald = 5.010$, $p < .05$. The estimated odds ratio showed a *negative* relationship of 62.3% decrease [*Exp (B)* =

.377], 95% CI (.160, .886)] for every one unit increase of educational attainment (see Table 23).

Table 23

Logistic Regression Analysis Between Language Acculturation Score (IV) and Healthy Eating (DV2) Adjusting for Confounders at Baseline Stage

			95% CI for *OR*	
	Sig.	*OR*	Lower	Upper
Age	< .001	1.063	1.045	1.081
Male gender[a]	< .001	.453	.355	.577
No schooling or less than 5th grade	.016	.335	.137	.816
5th–8th grade	.036	.391	.163	.938
9th–12th grade	.025	.377	.160	.886
Some college OR bachelor's degree	.124	.501	.208	1.208
At least some graduate school[b]	.086	--		
Years in the United States	.087	.991	.981	1.001
Language acculturation score	.051	.994	.988	1.000

[a]The reference group for the gender category was “Female.” [b]The reference group for the educational attainment category was “At least some graduate school.”

Overall, the confounding variables age, gender, and educational attainment (except in the “Some college or bachelor’s degree” category) caused the association of language acculturation to lose its statistical significance (p = .051), showing a negative confounding effect or towards a no association between language acculturation score and healthy eating for older, male participants with more educational attainment.

Logistic regression analyses: Language acculturation score and being active. Bivariate regression analyses were conducted between language acculturation score (IV) and being active (DV3) to analyze the association with language acculturation score independent from confounders. The logistic regression analyses were conducted for the three study stages (baseline, 2-year follow-up, and 5-year follow-up). The independent variable language acculturation score proved to have an association with statistical significance at the three study stages (baseline, 2-year follow-up, and 5-year follow-up).

At the BPRHS baseline stage, the logistic regression between language acculturation score (IV) and being active (DV3) was conducted. The predicting variable, language acculturation score, was tested a priori to verify there was no violation of the assumption of the linearity of the logit. In the logistic regression analysis, the predictor variable, language acculturation score, was found to contribute to the model. The unstandardized Beta weight for the Constant; B = (-.241), SE = .078, $Wald$ = 9.524, $p <$ .05. The unstandardized Beta weight for the predictor variable: $B = .018$, SE = .002, $Wald$ = 55.171, $p < .001$. The estimated odds ratio showed an increase of nearly 2.0% [*Exp(B)* = 1.019, 95% C.I. (1.014, 1.024)] for *being active* for every one unit increase of language acculturation score.

At the BPRHS 2-year follow-up stage, the logistic regression between language acculturation score (IV) and being active (DV3) was conducted. The predicting variable, language acculturation score, was tested a priori to verify there was no violation of the assumption of the linearity of the logit. In the logistic regression analysis, the predictor variable, language acculturation score, was found to contribute to the model. The unstandardized Beta weight for the Constant; B = (-.538), SE = .084, $Wald$ =41.136, $p <$ .001. The unstandardized Beta weight for the predictor variable: $B = .016$, SE = .003, $Wald$ = 37.430, $p < .001$. The estimated odds ratio showed an increase of nearly 2.0%

[*Exp(B)* = 1.016, 95% C.I. (1.011, 1.021)] for *being active* for every one unit increase of language acculturation score.

At the BPRHS 5-year follow-up stage, the logistic regression between language acculturation score (IV) and being active (DV3) was conducted. The predicting variable, language acculturation score, was tested a priori to verify there was no violation of the assumption of the linearity of the logit. In the logistic regression analysis, the predictor variable, language acculturation score, was found to contribute to the model. The unstandardized Beta weight for the Constant; *B* = (-.446), *SE* = .090, *Wald* = 24.602, $p < .001$. The unstandardized Beta weight for the predictor variable: *B = .020*, *SE* = .003, *Wald* = 42.222, $p < .001$. The estimated odds ratio showed an increase of 2.0% [*Exp(B)* = 1.020, 95% C.I. (1.014, 1.026)] for *being active* for every one unit increase of language acculturation score (see Table 24).

Table 24

Odds Ratios From Bivariate Logistic Regression Analyses Between Language Acculturation Score (IV) and Being Active (DV3) at the Three Study Stages

			95% CI for *OR*	
	Sig.	*OR*	Lower	Upper
Baseline	< .001	1.019	1.014	1.024
2-year follow-up	< .001	1.016	1.011	1.021
5-year follow-up	< .001	1.020	1.014	1.026

A binary logistic regression analysis was conducted to investigate if age, gender, educational attainment, number of years in the United States, and language acculturation score are factors associated with the participant's being active self-care skill. The Hosmer-Lemeshow goodness-of-fit was not significant ($p > .05$), indicating the model is correctly specified. Additionally, the *-2 log Likelihood* = 188.435 and the *Nagelkerke R squared* = .087. The model resulted in the independent variables educational attainment and number of years in the United States not significant ($p > .05$). However, the independent variable age was found to be significant ($p < .001$), and the independent variable gender was also found to be significant ($p < .05$). Controlling for educational attainment and number of years in the United States, the predictor variables, age, gender, and language acculturation score in the logistic regression analysis were found to contribute to the model. For age, the unstandardized $B = -.036$, $SE = .008$, $Wald = 19.339$, $p < .001$. The estimated odds ratio showed a *negative* relationship of nearly 4.0% decrease [*Exp (B)* = .964], 95% CI (.949, .980)] for every one year increase of age. For gender, the unstandardized $B = .266$, $SE = .123$, $Wald = 4.646$, $p < .05$. The estimated odds ratio showed an *increase* of nearly 31.0% [*Exp (B)* =1.305], 95% CI (1.024, 1.662)] for males compared to females. For language acculturation score, the unstandardized $B = .014$, $SE = .003$, $Wald = 21.311$, $p < .001$. The estimated odds ratio showed an *increase* of 1.4% [*Exp (B)* =1.014], 95% CI (1.008, 1.021)] for every one unit increase of language acculturation score (see Table 25).

Table 25

Logistic Regression Analysis Between Language Acculturation Score (IV) and Being Active (DV3) Adjusting for Confounders at Baseline Stage

			95% CI for *OR*	
	Sig.	*OR*	Lower	Upper
Age	< .001	.964	.949	.980
Male gender[a]	.031	1.305	1.024	1.662
No schooling or less than 5th grade	.189	.536	.211	1.360
5th–8th grade	.189	.540	.215	1.355
9th–12th grade	.314	.629	.254	1.553
Some college OR bachelor's degree	.199	.544	.215	1.377
At least some graduate school[b]	.532	--		
Years in the United States	.090	.992	.982	1.001
Language acculturation score	<.001	1.014	1.008	1.021

[a]The reference group for the gender category was "Female." [b]The reference group for the educational attainment category was "At least some graduate school."

The confounding variables age and gender were the only confounders showing statistically significant associations with being active. Notwithstanding, even after adjusting for confounders, including age and gender, the association between language acculturation score and being active remained a statistically significant association.

Logistic regression analyses: Language acculturation score and taking medication. Bivariate regression analyses were conducted between language acculturation score (IV) and taking medication (DV4) to analyze the association with language acculturation score independent from confounders. The logistic regression analyses were conducted for the three study stages (baseline, 2-year follow-up, and 5-year follow-up). The independent variable language acculturation score proved to have a statistically significant association with taking medication at the three study stages (see Table 26).

Table 26

Odds Ratios From Logistic Regression Analyses Between Language Acculturation Score (IV) and Taking Medication (DV4) at the Three Study Stages

			95% CI for *OR*	
	Sig.	*OR*	Lower	Upper
Baseline	< .001	.991	.986	.996
2-year follow-up	< .001	.990	.985	.996
5-year follow-up	.010	.992	.986	.998

At the BPRHS baseline stage, the logistic regression between language acculturation score (IV) and taking medication (DV4) was conducted. The predicting variable, language acculturation score, was tested a priori to verify there was no violation of the assumption of the linearity of the logit. In the logistic regression analysis, the predictor variable, language acculturation score, was found to contribute to the model. The unstandardized Beta weight for the Constant; B = (-.518), SE = .080, $Wald$ = 41.742, p < .001. The unstandardized Beta weight for the predictor variable: B = -*.009*, SE = .003, $Wald$ = 13.075, p < .001. The estimated odds ratio showed a decrease of nearly 1.0% [*Exp(B)* = .991, 95% C.I. (.986, .996)] for taking medication for every one unit increase of language acculturation score.

At the BPRHS 2-year follow-up stage, the logistic regression between language acculturation score (IV) and taking medication (DV4) was conducted. The predicting variable, language acculturation score, was tested a priori to verify there was no violation of the assumption of the linearity of the logit. In the logistic regression analysis, the predictor variable, language acculturation score, was found to contribute to the model. The unstandardized Beta weight for the Constant; *B* = (-.341), *SE* = .083, *Wald* = 16.646, *p* < .001. The unstandardized Beta weight for the predictor variable: *B = -.010, SE* = .003, *Wald* = 12.729, *p* < .001. The estimated odds ratio showed a decrease of 1.0% [*Exp(B)* = .990, 95% C.I. (.985, .996)] for taking medication for every one unit increase of language acculturation score.

At the BPRHS 5-year follow-up stage, the logistic regression between language acculturation score (IV) and taking medication (DV4) was conducted. The predicting variable, language acculturation score, was tested a priori to verify there was no violation of the assumption of the linearity of the logit. In the logistic regression analysis, the predictor variable, language acculturation score, was found to contribute to the model. The unstandardized Beta weight for the Constant; *B* = (-.219), *SE* = .089, *Wald* = 6.027, *p* < .05. The unstandardized Beta weight for the predictor variable: *B = -.008, SE* = .003, *Wald* = 6.690, *p* < .05. The estimated odds ratio showed a decrease of nearly 1.0% [*Exp(B)* = .992, 95% C.I. (.986, .998)] for taking medication for every one unit increase of language acculturation score (see Table 26).

The variables age, gender, educational attainment, and number of years in the United States were included as confounders after verifying an independent relationship with the dependent variable (healthy eating) or the independent variable (language acculturation score). A logistic regression analysis was conducted between language acculturation score (IV) and taking medication (DV4), adjusting for age, gender, educational attainment, and number of years in the United States as confounders. The

Hosmer-Lemeshow goodness-of-fit was *not* significant ($p > .05$), indicating the model is correctly specified. Additionally, the *-2 log Likelihood* = 1795.919 and the *Nagelkerke R squared* = .194. The model resulted in the independent variables age and gender, not significant ($p > .05$). However, the independent variable educational attainment was found to be significant in four of its categories “No schooling or less than 5th grade” ($p < .05$), “5th-8th grade” ($p < .001$), “9th-12th grade” ($p < .001$), and “Some college or bachelor’s degree” ($p < .05$). The independent variable number of years in the United States was found to be significant ($p <.05$), and the independent variable language acculturation score was also found to be significant ($p < .001$). In the logistic regression analysis, controlling for age and gender, the predictor variables, educational attainment, number of years in the United States, and language acculturation score, were found to contribute to the model. For the “No schooling or less than 5th grade” category of educational attainment, the unstandardized $B = -.944$, $SE = .335$, $Wald = 7.963$, $p < .05$. The estimated odds ratio showed a *negative* relationship of 61.1% decrease [*Exp (B)* = .389], 95% CI (.202, .749)] for every one unit increase of educational attainment. For the “5th – 8th grade” category of educational attainment, the unstandardized $B = -1.253$, $SE = .319$, $Wald = 15.414$, $p < .001$. The estimated odds ratio showed a *negative* relationship of 71.4% decrease [*Exp (B)* = .286], 95% CI (.153, .534)] for every one unit increase of educational attainment. For the “9th – 12th grade” category of educational attainment, the unstandardized $B = -1.341$, $SE = .302$, $Wald = 19.755$, $p < .001$. The estimated odds ratio showed a negative relationship of nearly 74.0% decrease [*Exp (B)* = .262], 95% CI (.145, .473)] for every one unit increase of educational attainment. For the “Some college or bachelor's degree" category of educational attainment, the unstandardized *B* = -1.083, *SE* = .326, *Wald* = 11.032, $p < .05$. The estimated odds ratio showed a *negative* relationship of 66.1% decrease [*Exp (B)* = .339], 95% CI (.179, .641)] for every one unit increase of educational attainment. For number of years in the United States, the unstandardized *B* = .015, *SE* = .005, *Wald* = 7.865, $p < .05$. The estimated odds ratio showed a *positive* relationship of 1.5% increase [*Exp (B)* =1.015], 95% CI (1.004, 1.025)] for every one unit increase of number of years in the United States. For language acculturation score, the unstandardized *B* = -.013, *SE* = .003, *Wald* = 17.745, $p < .001$. The estimated odds ratio showed a *negative* relationship of 1.3% decrease [*Exp (B)* =.987], 95% CI (.982, .993)] for every one unit increase of language acculturation score (see Table 27).

Table 27

Bivariate Logistic Regression Analyses Between Language Acculturation Score (IV) and Taking Medication (DV4) Adjusting for Covariates at Baseline

			95% CI for *OR*	
	Sig.	*OR*	Lower	Upper
Age	.273	1.007	.995	1.018
Male gender[a]	.091	.811	.636	1.034
No schooling or less than 5th grade	.005	.389	.202	.749
5th–8th grade	< .001	.286	.153	.534
9th–12th grade	< .001	.262	.145	.473
Some college OR bachelor's degree	.001	.339	.179	.641
At least some graduate school[b]	< .001	--	--	--
Years in the United States	.005	1.015	1.004	1.025
Language acculturation score	< .001	.987	.982	.993

[a]The reference group for the gender category was "Female." [b]The reference group for the educational attainment category was "At least some graduate school."

The confounding variables educational attainment and number of years in the United States were the only confounders showing statistically significant associations with taking medication. Notwithstanding, even after adjusting for confounders, including educational attainment and number of years in the United States, the association between language acculturation score and taking medication remained a statistically significant association.

Logistic regression analyses: Language acculturation score and healthy coping. Bivariate regression analyses were conducted between language acculturation score (IV) and healthy coping (DV5) to analyze the relationship with language acculturation score independent from confounders. The logistic regression analyses were conducted for the three study stages (baseline, 2-year follow-up, and 5-year follow-up). The independent variable language acculturation score proved to have an association with statistical significance only at the 2-year and 5-year follow-up study stages (see Table 28).

Table 28

Odds Ratios From Logistic Regression Analyses Between Language Acculturation Score (IV) and Healthy Coping (DV5) at the Three Study Stages

			95% CI for *OR*	
	Sig.	*OR*	Lower	Upper
Baseline	.083	.996	.991	1.001
2-year follow-up	.007	.993	.988	.998
5-year follow-up	< .001	1.017	1.011	1.023

At the BPRHS baseline stage, the logistic regression between language acculturation score (IV) and healthy coping (DV5) was conducted. The predicting variable, language acculturation score, was tested a priori to verify there was no violation of the assumption of the linearity of the logit. In the logistic regression analysis, the predictor variable, language acculturation score, was not found to contribute to the model. The unstandardized Beta weight for the Constant; *B* = (.259), *SE* = .077, *Wald* = 11.170, $p < .05$. The unstandardized Beta weight for the predictor variable: *B* = -.004, *SE* = .002, *Wald* = 3.000, $p > .05$. The estimated odds ratio showed a decrease of nearly 0.5% [*Exp(B)* = .996, 95% C.I. (.991, 1.001)] for healthy coping for every one unit increase of language acculturation score.

At the BPRHS 2-year follow-up, the logistic regression between language acculturation score (IV) and healthy coping (DV5) was conducted. The predicting variable, language acculturation score, was tested a priori to verify there was no violation of the assumption of the linearity of the logit. In the logistic regression analysis, the predictor variable, language acculturation score, was found to contribute to the model. The unstandardized Beta weight for the Constant; *B* = (.317), *SE* = .082, *Wald* = 14.892, $p < .001$. The unstandardized Beta weight for the predictor variable: *B = -.007, SE* = .003, *Wald* = 7.178, $p < .05$. The estimated odds ratio showed a decrease of nearly 1.0% [*Exp(B)* = .993, 95% C.I. (.988, .998)] for healthy coping for every one unit increase of language acculturation score.

At the BPRHS 5-year follow-up, the logistic regression between language acculturation score (IV) and healthy coping (DV5) was conducted. The predicting variable, language acculturation score, was tested a priori to verify there was no violation of the assumption of the linearity of the logit. In the logistic regression analysis, the predictor variable, language acculturation score, was found to contribute to the model. The unstandardized Beta weight for the Constant; *B* = (-.253), *SE* = .089, *Wald* = 8.073, *p*

< .05. The unstandardized Beta weight for the predictor variable: $B = .017$, $SE = .003$, *Wald* = 31.645, $p < .001$. The estimated odds ratio showed an increase of nearly 2.0% [*Exp(B)* = 1.017, 95% C.I. (1.011, 1.023)] for healthy coping for every one unit increase of language acculturation score.

A logistic regression analysis was conducted between language acculturation score (IV) and healthy coping (DV5), adjusting for age, gender, educational attainment, and length of stay in the United States as confounders. The Hosmer-Lemeshow goodness-of-fit was *not* significant ($p > .05$) indicating the model is correctly specified. Additionally, the *-2 log Likelihood* = 1942.952 and the *Nagelkerke R squared* = .053. The model resulted in one category of the independent variables educational attainment ("Some college or bachelor's degree"), and language acculturation score not significant ($p > .05$). However, the independent variable age was found to be significant ($p < .001$), the variable gender was found to be significant ($p < .001$), and the variable educational attainment was also found to be significant in three of its categories "No schooling or less than 5th grade" ($p < .05$), "5th-8th grade" ($p < .05$), and "9th-12th grade" ($p < .05$). Controlling for educational attainment ("Some college or bachelor's degree") and language acculturation score, the predictor variables, age, gender, educational attainment, and number of years in the United States in the logistic regression analysis were found to contribute to the model. For age, the unstandardized $B = -.048$, $SE = .008$, *Wald* = 33.197, $p < .001$. The estimated odds ratio showed a *negative* relationship of nearly 5.0% decrease [*Exp (B)* = .953], 95% CI (.938, .969)] for every one year increase of age. For gender, the unstandardized $B = -.419$, $SE = .120$, *Wald* = 12.318, $p < .001$. The estimated odds ratio showed a *decrease* of 34.3% [*Exp (B)* = .657], 95% CI (.520, .831)] for males compared to females. For the “No schooling or less than 5th grade” category of educational attainment, the unstandardized *B* = 1.121, *SE* = .452, *Wald* = 6.135, $p < .05$. The estimated odds ratio showed a *positive* relationship of nearly 207.0% increase [*Exp (B)* = 3.067], 95% CI (1.264, 7.446)] for every one unit increase of educational attainment. For the “5th – 8th grade” category of educational attainment, the unstandardized *B* = 1.105, *SE* = .446, *Wald* = 6.126, $p < .05$. The estimated odds ratio showed a *positive* relationship of nearly 202.0% increase [*Exp (B)* = 3.018], 95% CI (1.258, 7.238)] for every one unit increase of educational attainment. For the “9th – 12th grade” category of educational attainment, the unstandardized *B* = 1.034, *SE* = .436, *Wald* = 5.616, $p < .05$. The estimated odds ratio showed a *positive* relationship of 181.3% increase [*Exp (B)* = 2.813], 95% CI (1.196, 6.619)] for every one unit increase of educational attainment. For number of years in the United States, the unstandardized *B* = .011, *SE* = .005, *Wald* = 4.819, $p < .05$. The estimated odds ratio showed a *positive* relationship of 1.1% increase [*Exp (B)* = 1.011], 95% CI (1.001, 1.021)] for every one unit increase of number of years in the United States (see Table 29).

Table 29

Logistic Regression Analysis Between Language Acculturation (IV) and Healthy Coping (DV5) Adjusting for Confounders at Baseline

			95% CI for *OR*	
	Sig.	*OR*	Lower	Upper
Age	< .001	.953	.938	.969
Gender[a]	< .001	.657	.520	.831
No schooling or less than 5th grade	.013	3.067	1.264	7.446
5th–8th grade	.013	3.018	1.258	7.238
9th–12th grade	.018	2.813	1.196	6.619
Some college OR bachelor's degree	.134	1.959	.813	4.721
At least some graduate school[b]	.028			
Years in the United States	.028	1.011	1.001	1.021
Language acculturation score	.076	.995	.989	1.001

[a]The reference group for the gender category was “Female.” [b]The reference group for the educational attainment category was “At least some graduate school.”

All the confounding variables, age, gender, educational attainment (except in the “Some college or bachelor’s degree” category), and number of years in the United States caused the association of language acculturation to lose its statistical significance (p = .076), showing a negative confounding effect, or towards a no association between language acculturation score and healthy coping for older, male participants with more educational attainment and a longer stay in the United States.

Summary

The BPRHS data set analysis showed that among Puerto Ricans in Boston, the majority of them (74.5%) spoke only Spanish or mostly Spanish. Four factors, number of years in the United States, number of years in Massachusetts, waist circumference, and BMI were associated with diabetes prevalence with statistical significance. The independent variable, language acculturation score, was shown to have a statistically significant association with diabetes prevalence across the three study stages. Therefore, due to this relationship, the null hypothesis 1 (H01) is rejected, and the alternative hypothesis 1 (HA1) is accepted. Also, language acculturation score was shown to have statistically significant associations with the other dependent variables (healthy eating, DV2; being active, DV3; taking medication, DV4; and healthy coping, DV5) across the three study stages, with the exception of healthy coping at the baseline stage. Therefore, due to these relationships, the null hypothesis 2 (H02) is rejected, and the alternative hypothesis 2 (HA2) is accepted.

Four covariates were selected as potential confounders (age, gender, educational attainment, and number of years in the United States). After adjusting for confounders, the language acculturation score remained a statistically significant association with diabetes prevalence, being active, and taking medication. The confounder age showed statistical significance with all dependent variables except for taking medication. The confounder variables showed statistical significance only with certain dependent variables. These results and their potential implications for social change are discussed in the next chapter.

Chapter 5: Discussion

Introduction

The purpose of this dissertation study was to investigate the relationship between the use of a preferred language (Spanish), diabetes prevalence, and four selected self-care skills associated with diabetes (healthy eating, being active, taking medication, and healthy coping). This effect was analyzed using a subset of the H/L population living in the continental United States, specifically in the Boston metropolitan area. The selected study population included adult Puerto Ricans between the ages of 45 and 75 years. This population was recruited to be part of a longitudinal study called BPRHS between 2009 and 2017. The broad range of BPRHS variables allowed the quantitative statistical analyses of this dissertation study to answer the research questions and test the hypotheses.

The multiple statistical analyses conducted in this dissertation study have shown that the selected independent variable, language acculturation score, had statistically significant associations with diabetes prevalence, healthy eating, being active, taking medication, and healthy coping. However, the association of language acculturation score is not statistically significant at all study stages for all dependent variables. The gradient nature of language represented by the language acculturation score seems to present opportunities to improve the preventive and therapeutic options for people with or without a diabetes diagnosis with important social change implications, particularly in an understudied Spanish-speaking adult Puerto Rican population in the United States.

Interpretation of the Findings

Population Sample and Demographics

The BPRHS study involved an initial sample of 1,506 participants with a subsequent loss to follow-up at every study stage. A 16.5% loss to follow-up happened from baseline to 2-year follow-up, and a 23.6% loss to follow-up occurred from the 2-year follow-up to the 5-year follow-up stage. Overall, there was a 36.2% loss to follow-up from the baseline to the 5-year follow-up stage. Although the loss to follow-up between baseline and 2-year follow-up was less than 20%, the overall loss to follow-up of 36.2% may impact the interpretability and generalizability of the results (Dettori, 2011; LaMorte, 2016). The BPRHS data set did not include the reported death rate of participants. However, a percentage of the loss to follow-up from one study stage to the next may have occurred, especially in the eldest participants, thus potentially affecting not only the demographics but also the overall language acculturation distribution.

The gender distribution on the BPRHS data set favors female participants, who represent 70.5% (*n* = 1,059) of the study population at baseline, whereas male participants represented 29.5% (*n* = 443). This finding is consistent with Schneidermann et al. (2014), with more female than male participants in diabetes prevalence studies across racial and ethnic groups in the United States, as well as in studies including H/L populations(Cheng et al., 2019; Schneiderman et al., 2014).

The definition of diabetes prevalence in this dissertation study (glycosylated hemoglobin ≥ 6.5% or use of any six antidiabetic agents) resulted in 50.4% of diabetes prevalence at baseline, 51.0% at 2-year follow-up, and 50.0% at 5-year follow-up for

Puerto Ricans in Boston. These rates are higher than those indicated in recent publications reporting diabetes prevalence in Hispanic adults (18 years of age or older) as high as 24.6%, and ranging from 17.6% (with less than a high school diploma) to 21.7% in Puerto Ricans (Arroyo-Johnson et al., 2016; Cheng et al., 2019). A stratified report by age and race from the U.S. Diabetes Surveillance System showed the highest rates of diagnosed diabetes for Hispanic adults as 18.4% in 2010 (45-64 years of age), 35.2% in 2013 (65-74 years of age), and 37.4% in 2010 (75+ years of age; CDC, n.d.-b). It was expected that there would be high rates of diabetes prevalence rates in the BPRHS study population given the study population's age range (45–81 years of age); however, diabetes prevalence at 50% across study stages is an indication that there is a great need for further epidemiological studies stratifying data for Puerto Ricans with diabetes. Similarly, the high diabetes prevalence indicates that Puerto Ricans may require population-specific initiatives to address intracultural (H/L) and intercultural disparities in Puerto Rican populations.

Contributing Factors in Diabetes Prevalence

Multiple diabetes studies have shown that anthropometric measures have varying degrees of predictability for diabetes, hypertension, kidney disease, cardiovascular diseases, and metabolic syndrome (de Oliveira, Roriz, Ramos, & Neto, 2017; Guligowska et al., 2020; Liu et al., 2019; Luo et al., 2019). In this dissertation study, two anthropometric factors were included, BMI and waist circumference. The cutoff point was selected for waist circumference at 88 cm to adjust for gender (female). A recent meta-analysis identified 88 cm as a better predictor of diabetes in females (Seo, Choe, &

Torabi, 2017). Two additional factors, both reflecting length of stay in the continental United States, number of years in the United States, and number of years in Massachusetts, were also included in the statistical analyses. All four factors showed statistically significant associations with diabetes prevalence.

Both waist circumference and BMI showed a statistically significant association with diabetes prevalence across the study stages. This result is not surprising, given that 56.7% of the study participants showed body mass indices within the range of obesity (BMI ≥ 30). Additionally, 30.2% of study participants were already in the overweight category, according to their BMI (25 ≤ BMI < 30), suggesting that more Puerto Ricans may be on their way to developing diabetes as they age.

Concerning the length of stay in the continental United States, 94.5% of Puerto Ricans in the study had a length of stay in the United States ≥ 10 years. Recent publications have indicated that length of residence in the United States ≥ 10 years is associated with a higher prevalence of chronic diseases such as diabetes, obesity, and hypertension (Bullard et al., 2018; Commodore-Mensah et al., 2016; Fryar, Fakhouri, Carroll, Frenk, & Ogden, 2020).

Lack of immigration restrictions and the right to U.S. citizenship at birth provides a different starting point to Puerto Ricans compared to other H/L populations, particularly first-generation immigrants. However, Valle (2020) posited that Puerto Ricans perceive their U.S. citizenship as conferring unequal citizen status and thus not granting them membership into the American community, a phenomenon that may explain the differences in dietary, educational attainment, and epidemiological behavior in Puerto

Ricans (Mattei, McClain, Falcón, Noel, & Tucker, 2018; Mattei et al., 2018; Valle, 2019). The combination of an extended length of stay and high values of waist circumference and BMI may explain the high rate of diabetes prevalence with stability across study stages.

Language Acculturation

The language acculturation process that Puerto Ricans go through during their stay in the United States should be a dynamic process of change and adaptation (Fox et al., 2017; Martinez, 2010). As a gradient, this change is a closer approach to reality than a binary approach of speaking one language or the other. In Boston Puerto Ricans, the language acculturation process showed statistical significance when compared across the three study stages, indicating that the change in language acculturation is indeed a dynamic and progressive process (see Appendix J). At an epidemiological level, this finding provides an opportunity to better understand the need for interventions that include language as a dynamic element of acculturation to potentially reduce the high prevalence of diabetes in Puerto Ricans. Although statistically significant at every study stage, the change in language acculturation did not change the low mode value of language acculturation score (.000) across study stages (see Table 16). Unlike the language acculturation score, diabetes prevalence did not show statistically significant changes across the three study stages (see Appendix K). The BPRHS participants showed a consistently high preference for using the Spanish language over English based on the four parameters of language use (native language, language mostly spoken, language of interview, and language acculturation score). As indicated before, the BPRHS had a loss to follow-up of 16.5% from baseline to 2-year follow-up, and 23.6% from 2-year follow-up to 5-year follow-up; this loss of participants from one study stage to the next may have been a contributor to the decrease in language acculturation scores across study stages. Such a decrease is also verified in the decrease of the median of language acculturation score across study stages and the increase in the age median at baseline (56.0), 2-year follow-up (58.0), and 5-year follow-up (62.0). The majority of adult Puerto Ricans from the study population (96.3%) showed a greater preference to speak their native language as they aged.

Despite the statistically significant decrease of language acculturation score across study stages, its mode remained unchanged across study stages too. This may be due to a broad base of low language acculturation score values also across study stages. Although the loss to follow-up of participants affects the language acculturation score median values at every study stage, it shows an even decrease across the study population over time, with a distribution that changes over time but with a similar skewed frequency distribution overall (see Figures 2, 3, and 4).

Effects of language acculturation on diabetes prevalence. The language acculturation score showed a negative and inverse relation with diabetes prevalence in the three study stages. Higher language acculturation scores (more use of the English language) indicated that diabetes prevalence decreased (-1.0%) at baseline (*OR* = .990, $p < .001$), -1.1% at 2-year follow-up (*OR* = .989, $p < .001$), and -0.8% at 5-year follow-up (*OR* = .992, $p < .05$). The bivariate logistic regression analyses indicated that the effect of language acculturation on diabetes prevalence in the study population seems modest.

Although modest, the effect is consistent. When Puerto Ricans increased their language acculturation, diabetes prevalence decreased. This modest effect may be due to the definition of diabetes prevalence for this dissertation study, which included two factors, an updated glycosylated hemoglobin value ($\geq$ 6.5%) and the use of any of six antidiabetic medications. This modest yet consistent decreasing effect of language acculturation over diabetes prevalence is consistently almost twice as high as the decrease in glycosylated hemoglobin reported by Osborn et al. (2010). In that study, the authors applied a culturally and linguistically tailored intervention program addressing diet label reading, diet adherence, physical activity, and glycemic control to Puerto Ricans with T2D. The authors reported a 0.48% decrease with statistical significance in glycosylated hemoglobin (Osborn et al., 2010). Compared to Osborn et al. (2010), the individual negative association of language acculturation score with diabetes prevalence in this study (containing glycosylated hemoglobin as one of its components) is consistently higher across study stages (-1.0% at baseline, -1.1% at 2-year follow-up, and -0.8% at 5-year follow-up), with higher than a twofold difference at baseline and 2-year-follow-up.

After adjusting for confounding variables (age, gender, educational attainment, and number of years in the United States), the logistic regression analysis between language acculturation score and diabetes prevalence indicated that language acculturation score and age were associated with diabetes prevalence with statistical significance. For age, the association was positive (OR = 1.051, p < .001), indicating that diabetes prevalence increased (5.1%) as participants aged. For the language acculturation score, the association was negative (*OR* = .993, $p < .05$), indicating that diabetes prevalence decreased (-0.7%) with higher language acculturation scores.

In this study, the negative association of language acculturation score with diabetes prevalence showed statistical significance with or without the effect of confounding variables. Similarly, this association across the BPRHS stages indicates that the trend of the effect is maintained over time with minimum variation, despite loss to follow-up across the study stages, and the slight increase and subsequent decline of the effect when going from baseline to 2-year follow-up and from the 2-year follow-up to the 5-year follow-up (see Figures 5, 6, and 7). A concomitant effect between language acculturation score and age may be influencing diabetes prevalence, as both variables were shown to be the only predictors with statistical significance after adjusting for other confounding variables.

Although the risk of developing diabetes generally increases with age, a recent report has indicated that there seems to be an epidemiological shift that indicates that diabetes, particularly T2D, is no longer a middle-aged disease as young-onset T2D is growing rapidly, particularly in North America (Magliano, Sacre, Gregg, Zimmet, & Shaw, 2020). The effect of language acculturation to predict a decrease in diabetes prevalence is maintained with or without adjustment for confounders. Given that the language acculturation score does have a statistically significant association with diabetes prevalence, the null hypothesis (H01) is rejected, and the alternative hypothesis (HA1) is accepted.

Effects of language acculturation on Diabetes Self-Care Skill 1: Healthy eating. The variable healthy eating was calculated using the Healthy Eating Index 2005 (HEI2005), a scale created to measure overall diet quality in relation to the U.S. Dietary Guidelines for Americans (Guenther, Reedy, & Krebs-Smith, 2008; U.S. DHHS, 2005). The logistic regression analysis results between language acculturation score and healthy eating showed a negative association with statistical significance (OR = .998, $p < .001$) at baseline, the only study stage where the HEI2005 data were available from the BPRHS data set. The association between language acculturation score and healthy eating (OR = .988, $p < .001$) is very similar to the effect obtained with diabetes prevalence at baseline (OR = .990, $p < .001$).

The effect of decreasing the healthy eating index may seem detrimental to the study population's overall diet quality, particularly because the HEI2005 was inversely associated with the risk of major chronic diseases in both males and females (Chiuve et al., 2012). However, the HEI2005 provided an overall idea of the diet quality and adherence to the 2005 Dietary Guidelines for Americans, with high scores attributed to the use of dairy and meats (Guenther, Reedy, Krebs-Smith, Reeve, & Basiotis, 2007; NCI, 2020). Both foods (dairy and meats) are associated with diabetes (Kouvari, Notara, Kalogeropoulos, & Panagiotakos, 2016; Willett & Ludwig, 2020). Traditional diets from Mexico and Puerto Rico include frequent intake of staples such as rice and beans (Jannasch, Kröger, & Schulze, 2017). In Puerto Ricans, following such traditional dietary patterns involves more use of Spanish, stronger psychological Puerto Rican orientation, and shorter length of stay in the United States (Mattei, McClain, Falcón, Noel, & Tucker, 2018). The effect of language acculturation on dietary patterns in Boston Puerto Ricans may provide an opportunity to revisit the use of traditional diets with high consumption of rice and beans and low meat consumption to reduce the risk of diabetes. This is also in agreement with Chiuve et al. (2012), who identified that the individual HEI2005 components that were independently associated with less chronic disease were vegetables (dark green and orange), whole fruit, and whole grains. Additionally, McClain et al. (2018) used the HEI 2005 with the BPRHS data set, based on the premise that high HEI 2005 scores indicate better diet quality. The authors identified that diet quality (HEI2005) moderated the food insecurity status and allostatic load or cumulative physiological wear-and-tear on the body systems of study participants in response to multiple stressors (McClain et al., 2018). The healthy eating factor also bears great importance to address the high concentration of BPRHS participants (88.3%) with a total household income of less than $30,000 per year and the potential food insecurity that they may be experiencing.

In a second logistic regression analysis, adjusting for age, gender, educational attainment, and number of years in the United States, only age, gender, and educational attainment showed statistical significance. For age, there was a positive association (*OR* = 1.063, $p < .001$), indicating a 6.3% increase in healthy eating (HEI2005) with every unit increase of age. This result agrees with the notion from the 2005 U.S. Dietary Guidelines for Americans that an increase in age resulted in an increase in overall diet quality. For gender, the results indicated that males are much less likely to practice healthy eating habits compared to females (*OR* = .453, $p < .001$). The confounding effect of age, gender, and educational attainment changed the association between language acculturation score and healthy eating, showing a hidden effect (negative confounding) in the logistic regression analysis. The gender factor may play a role in the dietary habits based on the traditional reliance of Puerto Rican men on women (spouses) for their adherence to diet and medication (Torres-Pagán & Toro-Alfonso, 2017).

Effects of language acculturation on Diabetes Self-Care Skill 2: Being active. The bivariate logistic regression analyses between language acculturation score and being active showed a positive association with statistical significance across study stages. These results indicate that Puerto Ricans with higher language acculturation score (more use of English) showed higher physical activity (being active) across the study stages. Although statistically significant, the positive association with being active seems to be modest and opposite to the negative association with diabetes prevalence and healthy eating. The benefits of physical activity may not be apparent in relation to diabetes, as diabetes prevalence remained high and stable (50%) across study stages. Among Puerto Ricans in Boston, the interactions between physical activity, healthy eating, and diabetes prevalence seem to be complex and not evident. Vercammen, McClain, Tucker, Falcón, and Mattei (2019) described such complexity reporting that BPRHS Puerto Ricans had a lower physical activity with more psychological acculturation (more identification with Americans), a scale used to measure the preferred identification with the Puerto Rican or American cultures, a factor that increases over time in Puerto Ricans (Vercammen, McClain, Tucker, Falcón, & Mattei, 2019). Similarly, Kershaw et al. (2016) used data from The Hispanic Community Health Study/Study of Latinos to report that H/L populations showed lower physical activity with longer lengths of stay in the United States. Physical activity among Puerto Ricans seems higher with more language acculturation (more use of English language) but lower when psychological acculturation is higher (Vercammen, McClain, Tucker, Falcón, & Mattei, 2019). This apparent contradictory effect may be explained by the conflict between self-identity impacted by the complex relationship between Puerto Rico and the United States and the extended length of stay of Puerto Ricans in the continental United States.

Adjusting for confounding variables (age, gender, educational attainment, and number of years in the United States), the logistic regression analysis between language acculturation score and being active indicated that language acculturation score, age, and gender had a statistically significant association with the variable being active. For age, the association was negative, indicating that physical activity decreased (-3.6%) as participants aged. For gender, the association was positive, indicating that male participants were more physically active (30.5%) compared to female participants. For language acculturation score, the association was positive, indicating that physical activity increased (1.4%) with more language acculturation (more use of English language). The decrease of physical activity with age is expected, and the higher rate of physical activity in males is similar to reports from other studies focused on H/L populations, in some cases with women showing almost twice the rate of inactivity compared to men (Arredondo et al., 2016; Kershaw et al., 2016; Larsen, Noble, Murray, & Marcus, 2015). This difference in physical activity between male and female study participants may be due to transportation and physical activity related to work in Puerto Ricans living and working in large metropolitan areas like Boston.

In Puerto Ricans, physical activity has also been shown to attenuate memory decline (Loprinzi, Scott, Ikuta, Addoh, & Tucker, 2019). Given the age range of the study participants across study stages (45 years to 81 years) and the positive associations of language acculturation score with being active and healthy eating, study participants should have a healthier outcome and decrease in diabetes prevalence. This effect was not identified as diabetes prevalence remained almost unchanged across study stages, a finding that may warrant the need for qualitative and mixed methods studies to identify the complex relationship between language acculturation, dietary habits, and physical activity in Puerto Ricans.

Effects of language acculturation on Diabetes Self-Care Skill 3: Taking medication. This self-care skill bears particular therapeutic importance due to the finding that diabetes prevalence is consistently high at or almost 50% in BPRHS participants across the three study stages. The variable taking medication was used as part of the diabetes prevalence variable calculation and separately as a self-care skill. In the case of the diabetes prevalence variable, taking medication was used to reinforce the concept of prevalence to include participants with diabetes diagnosis and treatment and not just a clinical diagnosis. The separate analysis of language acculturation score and taking medication was meant to analyze the specific relationship with a self-care skill (behavior) that is an intricate part of the long-term care of the disease.

The independent variable, language acculturation score, showed a negative association with taking medication at the three study stages, similar to the findings shown with diabetes prevalence and healthy eating. Higher language acculturation scores (more use of the English language) indicated that taking medication decreased at the baseline, 2-year follow-up, and 5-year follow-up stages (-0.9%, -1.0%, -0.8%, respectively). The results of taking medication decrease are comparable and congruent with the decrease of diabetes prevalence at the baseline, 2-year follow-up, and 5-year follow-up stages (-1.0%, -1.1%, and -0.8%, respectively), where lower diabetes prevalence should correlate with a lower likelihood of taking medication for diabetes.

After adjusting for confounding variables (age, gender, educational attainment, and number of years in the United States), the logistic regression analysis between language acculturation score and taking medication indicated that language acculturation score, educational attainment, and number of years in the United States had statistically significant associations with taking medication. For educational attainment, the association was negative for all its categories, with a 61.1% decrease for “No schooling or less than 5th grade,” with a 71.4% decrease for “5th grade - 8th grade,” with a 73.8% decrease for “9th grade - 12th grade,” and with a 66.1% decrease for “Some college or bachelor’s degree.” For number of years in the United States, the association was positive, indicating that taking medication increased 1.5% with a greater number of years in the United States. For language acculturation score, the association was negative, indicating that taking medication decreased by 1.8% with higher language acculturation scores.

For taking medication, the results from the logistic regression analysis with language acculturation score adjusting for confounders showed that participants had a progressively decreasing likelihood of taking medication as educational attainment levels increased progressively from no schooling to high school. This trend is also verified with a statistically significant increase of 1.5% in the likelihood of taking medication with a longer stay in the United States. The negative association of language acculturation score on taking medication remained statistically significant with confounders, with a slightly higher decreasing effect when confounders were present. In a 2015 qualitative study with Puerto Ricans from Boston, the authors reported similar results, identifying four main themes: the embodiment of medication use, medications redefining self through the fabric of daily life, healthcare experience defined through medication, and medicine dividing the island and the mainland (Adams, Todorova, Guzzardo, & Falcon, 2015). The four themes reflect the interwoven relationship between acculturation, and the construction of the sense of self, factors that are addressed by the theory of language barriers with the aspects of barriers of interaction (addressivity), and the perceived balance of power due to an inequitable communication due to limited English proficiency or low language acculturation score (Martinez G., 2010).

Effects of language acculturation on Diabetes Self-Care Skill 4: Healthy coping. As stated in chapter 4, the operationalization of the variable healthy coping involved the use of perceived stress score as the variable to measure participants' inverse coping skills. For this dissertation study, lower perceived stress score was interpreted as greater healthy coping skills. The bivariate logistic regression analyses indicated that language acculturation score showed a statistically significant negative association with perceived stress score at the 2-year follow-up stage and a statistically significant positive association with perceived stress score at the 5-year follow-up stage. At the 2-year follow-up, perceived stress score decreased 0.7% and increased 1.7% at the 5-year follow-up. These results indicate that over time, the association of language acculturation score was reversed from negative (decrease) to positive (increase). Interpreting the results inversely for healthy coping, the effect of language acculturation score goes from increasing healthy coping to decreasing healthy coping from the 2-year follow-up to the 5-year follow-up study stages.

After adjusting for confounding variables (age, gender, educational attainment, and number of years in the United States), the logistic regression analysis between language acculturation score and perceived stress score indicated that age, gender, educational attainment (except "Some college or bachelor's degree"), and number of years in the United States had statistically significant associations with perceived stress score. For age, the association was negative, indicating that perceived stress score decreased 4.7% as participants aged. For gender, the association was negative, indicating that perceived stress score decreased by 34.3% for males compared to females. For educational attainment, the association was negative for all its categories, with a 206.7% decrease for "No schooling or less than 5th grade," with a 201.8% decrease for "5th grade - 8th grade," and with a 181.3% decrease for "9th grade - 12th grade." For number of years in the United States, the association was positive, indicating that perceived stress score increased 1.1% with a greater number of years in the United States.

The association of language acculturation score with perceived stress score (healthy coping) changed both over time and when adjusted for confounders. Among the confounders, gender had a greater effect than age over perceived stress score. However, the educational attainment categories (except “Some college or bachelor’s degree”) had a greater association that decreased progressively from no schooling to 12th grade. Therefore, when adjusting for confounders, age had a negative association with healthy coping, and male (gender) participants had greater healthy coping skills compared to females, a finding that is similar to other reports including Latino and Puerto Rican populations (Cervantes, Gattamorta, & Berger-Cardoso, 2019; Panchang, Dowdy, Kimbro, & Gorman, 2016). Also, BPRHS participants had progressively greater healthy coping skills with more educational attainment and less healthy coping skills with a longer stay in the United States. In a 2015 study, the connection between language acculturation, stress, and crime in Puerto Ricans was identified, particularly in Puerto Rican men being three times more likely to have had police contact, a disproportionate finding that agrees with male offending at the national level (Adams, Todorova, & Falcón, 2015). In a 2020 research study, the authors reported that almost two-thirds of BPRHS Puerto Ricans were at risk of clinical depression. This phenomenon is associated with exposure to recent perceived unfair treatment (Bongki, Kaipeng, & Falcón, 2020). The reversal of a positive to a negative association of language acculturation and healthy coping identified in this dissertation study between the 2-year and 5-year follow-up stages can be better understood with the 2015 and 2020 studies mentioned above, and with the barriers described by the theory of language barriers (barriers of interaction, uneven distribution of health information, and acceptance), setting Puerto Ricans at a lower social relative standing, with inequities at the linguistic, cultural, and healthcare levels.

Validating the Theoretical Framework

This study's theoretical framework combined two theories, the health belief model (HBM) with proven results for more than six decades, and a newer theoretical proposal, the theory of language barriers (TLB). Both theories act in conjunction to explain the psychosocial effects of beliefs and perceptions guided by the acculturation and language acculturation processes in the study population. The constructs of the HBM and TLB work in conjunction to explain a decrease in the onset of the disease (diabetes) with better knowledge and understanding of the perceived susceptibility, barriers, and severity of the disease, because of more use of English (greater language acculturation score), and the interaction of the uneven distribution of information in English and the diminished addressivity (intersubjectivity) of the predominant or exclusive speakers of the Spanish language interacting with English-only speakers. Similarly, the TLB's performance barriers construct acts synergistically with the HBM's cues to action and self-efficacy to predict the benefits of greater language acculturation as a predictor of self-efficacy to manage the disease, as shown in the statistically significant effect of language acculturation on the four selected self-care skills (healthy eating, being active, taking medication, and healthy coping; Martinez G., in press; Smith-Miller, Berry, DeWalt, & Miller, 2016; Thomas N. M., 2018). This synergistic effect between the two theories can shed light on the intricacies of the multidimensional aspect of the acculturation continuum where language, culture, self-identity, ethnicity, perceptions, and health behaviors interact to produce gradient effects in health and wealth. Both the HBM and TLB theories benefit from each other's tenets and provide new opportunities to building initiatives that use the heterogeneity of Spanish-speakers and their language acculturation as pillars to enhance the sensitivity of health communication and health promotion initiatives to both factors to exert positive changes towards a better understanding of disease risk factors, disease prevention, and treatment adherence that can lead to more preventive efforts rather than relying purely on long-term therapeutic approaches so that the long-term and detrimental consequences of diabetes are avoided or ameliorated.

Limitations of the Study

As stated previously in Chapter 1, this study included the use of a secondary data set from an ongoing longitudinal study, the Boston Puerto Rican Health Study. As the data was collected from a specific geographical location (Boston), there are general limitations to this dissertation study, and its finding should be cautiously considered based on that context. Additionally, as the BPRHS data set included data from the residents of Boston, a major metropolitan area on the northeast side of the United States, the data may present specific geographical characteristics that may have impacted the educational attainment and socioeconomic status of the study participants. The link between socioeconomic status through the total household income was not assessed in this dissertation study, a factor that may have had an impact on the language acculturation score and thus impacting diabetes prevalence and the development of the four self-care skills that were associated with language acculturation.

There are threats to internal validity due to the use of multiple psychological and clinical protocols and scales. However, these threats were reduced by using previously validated protocols and scales (perceived stress and language acculturation scales). Additionally, the ongoing publication of research studies from the BPRHS further validates the use of the BPRHS data set as a reliable source of information.

Another limitation includes the specific recruitment of one H/L subpopulation, adult Puerto Ricans in Boston. Bias in the self-identification of the BPRHS participants as Puerto Ricans may have been influenced by factors such as socioeconomic status, social perceptions, beliefs, self-identity, and acculturation mechanisms, biasing the results towards a greater Puerto Rican self-identification, or more use of Spanish that may have been reflected in the consistently low language acculturation scores. These factors may also influence the characterization of their self-reported health and self-care skills over time, given the longitudinal nature of the original study.

Finally, the loss to follow-up may bias the results due to inconsistency in the collection of data and its potential threat to the generalizability of the results of this dissertation study. However, this follow-up bias, if present, did not affect the overall diabetes prevalence. Another threat to the extension of the study is the specificity of local conditions in Boston that may jeopardize the generalizability of the results to other states or metropolitan areas. The extended stay of the BPRHS participants may indicate a clustering effect that may perpetuate the low language acculturation in Puerto Ricans that feel comfortable living in areas with a high density of Puerto Ricans and less incentive to speak more English. Similarly, the specific recruitment of a subset of the H/L population in the United States with unique characteristics may also threaten the generalizability of the results to other H/L subpopulations in the United States.

Recommendations for Future Research

The literature gap for Puerto Ricans as an understudied Spanish-speaking population presents multiple opportunities for future research involving diabetes health communication, prevention, and disease management. Prospective and retrospective studies are necessary to identify the major factors that influence the development and progression of diabetes in young and older Puerto Ricans. Further research in young adults may help to identify the linguistic, cultural, and population factors necessary to design culturally and linguistically appropriate initiatives. These initiatives may represent the gateway to address specific needs from Puerto Ricans (language learning, health literacy, nutrition literacy), to potentially reduce the onset and long-term effects of chronic diseases, particularly T2D that represents between 90% and 95% of reported diabetes in the United States (CDC, 2020b).

The immediate factors that require special attention are the current intracultural differences among H/L populations within the life spectrum from childhood to adulthood. Although these intracultural differences have been previously reported, they have not been updated in recent years (Vega, Rodriguez, & Gruskin, 2009). More importantly, it is in recent years that immigrant H/L populations have suffered the unrest and uncertainty that a negatively and politically-charged targeting effort continue shadowing their daily lives, posing potential ethical challenges in health care and poorer health outcomes (Hamilton, Hale, & Savinar, 2019; Kim, Sanchez Molina, & Saadi, 2019). Although

Puerto Ricans are not considered immigrants and should not be subject to the difficulties of immigration status as a stressful factor, they are seldom free of population-based problems. Recently, several political and economic changes and natural disasters have exposed the weak infrastructure and overall economic situation of Puerto Rico and Puerto Ricans, causing an out-migration from Puerto Rico to the mainland (Santos-Lozada, Kaneshiro, McCarter, & Marazzi-Santiago, 2020). This devastating reality continues eroding the relationship between the island of Puerto Rico and the United States government. Overall, these recent changes have impacted health care and public health levels that require further analysis.

From a nationwide perspective, research on healthcare disparities in H/L populations is of great importance. Since 2016, new social, cultural, and political conditions have dramatically changed the United States' healthcare landscape with ongoing systematic attempts to dismantle the Patient Protection and Affordable Care Act (PPACA; Jost & Keith, 2020). This law started to reduce the abysmal disparities in access to health care in the H/L populations that exhibited the highest rate of uninsurance in the United States prior to the PPACA was enacted in 2014. Although recent attempts to disintegrate non-discrimination factors from PPACA’s Section 1557 have met partial upholding thanks to federal and U.S. Supreme Court resolutions, the uncertainty and potential detrimental financial impact of the return of high uninsured rates of politically and economically vulnerable H/L populations may be an upcoming reality (Keith, 2020).

At a granular level, reaching out to communities using culturally and linguistically appropriate services can help determine the importance of factors such as health literacy and nutrition literacy. Both factors influence the onset and management of chronic diseases (Guntzviller, King, Jensen, & Davis, 2017; Velardo, 2015). Of particular importance is the need for research to identify the interactions between language, culture, nutrition, and physical activity in Puerto Ricans so that long-term, sustainable, health-promoting nutritional initiatives are used to address the onset and management of chronic diseases.

Implications for Social Change

Global estimates indicate that by 2045, 693 million people will have diabetes worldwide (Cho et al., 2018). Using preventive measures to reduce this projected number should be of public health, clinical, social, economic, ethical, and cultural importance. Using culturally and linguistically appropriate measures that address the cultural and linguistic needs of Puerto Ricans might contribute to ameliorate the local and global burden of disease. These interventions should address language in conjunction with two major aspects, health literacy and nutrition literacy. Language and literacy skills are key factors that can work concomitantly to disseminate and apply findings that foster understanding of the disease process and apply direct culturally-appropriate interventions. For example, using findings from recent studies that indicate that plant-based diets may have a reversal effect on diabetes (Chowdhury, 2017; McMacken & Shah, 2017; Wright, Wilson, Smith, Duncan, & McHugh, 2017), combining traditional food staples (rice and beans) with updated information. Although there are initiatives and interventions designed to address diabetes, these efforts tend to favor pharmaceutical or generalized public health initiatives, largely ignoring the effect of language acculturation on diabetes prevalence, self-care skills, and disease management among Spanish-speaking immigrants and non-immigrants like Puerto Ricans (LeRoith et al., 2019). The literature gap identified in the effect of language acculturation on diabetes prevalence is proof of the lack of consistent inclusion of language as a pillar in public health research towards minority and limited English proficient populations in the United States. The unique situation that Puerto Ricans have by being deemed citizens at birth should provide them with the same opportunities that native populations have on access to care and not with fewer opportunities and poorer outcomes, as other minority populations show in the United States. There are epidemiological similarities between Puerto Ricans and low-income African Americans, both minority groups that consistently show the consequences of healthcare disparities in access to electronic health records, chronic diseases, Covid-19, and self-rated health (Colen, Ramey, Cooksey, & Williams, 2018; Greenaway et al., 2020; Kim et al., 2018; Lyles et al., 2016; Roberts & Rodgers, 2020; Tai, Shah, Doubeni, Sia, & Wieland, 2020).

Initiatives using a community-based participatory research (CBPR) approach should be used as solid and sustainable tools to include Puerto Ricans in their journey to shed light on factors that can help them in the prevention of chronic diseases, as well as learning and implementing the demanding long-term disease management skills that chronic diseases require. The use of CBPR initiatives can also enhance the sense of autonomy and inclusion of Puerto Ricans in the coordination of public health, health care, and scientific efforts. This is of particular importance due to the massively detrimental effects of recent natural disasters in infrastructure and the economy of the island of

Puerto Rico that has generated a massive influx of Puerto Ricans into the continental United States (Santos-Lozada, Kaneshiro, McCarter, & Marazzi-Santiago, 2020). More recent events show the alarming vulnerability of minority H/L populations to current pandemics (Covid-19) with high infectious and mortality rates due to high prevalence rates of diabetes, obesity, respiratory and cardiovascular diseases (Clark, Fredricks, Woc-Colburn, Bottazzi, & Weatherhead, 2020; CDC, 2020b, 2020c; Hales, Carroll, Fryar, & Ogden, 2020; Stern, Pier, & Litonjua, 2020).

Conclusions

Acculturation is a complex and progressive process that impacts most, if not all, the main aspects of Puerto Ricans living in the United States. For Puerto Ricans, those aspects include the length of residence in the United States, educational attainment, dietary habits, physical activity, and disease risks, with language acculturation as a driver of this process. The permeating effects of acculturation and language acculturation are intertwined within the lives and perceptions of Puerto Ricans that live and endure their diaspora in Boston and other highly-populated metropolitan areas. Social constructs such as race and self-identity are also influenced by both acculturation and language acculturation. Puerto Ricans are not indifferent to feeling the effects of long residence in the United States, with consequential increased risks to develop chronic diseases like diabetes, due to poor dietary habits, relative sedentarism, and educational attainment lower than most other racial and ethnic groups.

Language should no longer be taken as a static skill, but as a dynamic process that changes over time and with underlying effects that can mediate the changing nature of people's self-identity, health literacy, nutrition literacy, and decision-making process. This study aimed to mend a literature gap where Puerto Ricans are largely ignored from the research literature even though they represent the second-largest H/L population in the United States and one of the fastest-growing demographic groups whose identity and destiny remains uncertain for decades. The importance of language acculturation in this study is shown in the statistically significant decreasing effect over diabetes prevalence across the three study stages (baseline, 2-year follow-up, and 5-year follow-up). Similarly, language acculturation also showed associations with the four selected self-care skills (healthy eating, being active, taking medication, and healthy coping) with statistical significance in some of the study stages, with findings and tendencies that are reported by older and newer research studies approaching H/L populations as a unit, or specific to Puerto Ricans in the United States.

Given that language acculturation score does have an association with all the dependent variables across study stages (except with healthy coping at baseline), even after adjusting for confounders (except for healthy eating and healthy coping), the null hypothesis (H02) is rejected, and the alternative hypothesis (HA2) is accepted. The findings of this study, concentrated in a study population of Puerto Ricans based in Boston, indicate that there are opportunities to cautiously extrapolate the results to other states in the country with high Puerto Rican population density, particularly on the eastern side of the United States (Florida, Pennsylvania, and New Jersey), where Puerto Rican populations are predominantly concentrated. The findings of this study also suggest that the use of initiatives that include language and acculturation are necessary constructs to achieve lower levels of diabetes prevalence and improvements in self-care skills as supported and predicted by the theoretical framework composed of the health belief model and the theory of language barriers.

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Appendix A: Language Acculturation Score (CACCULTUR)

Question	Answer					Variable
1. What is your native language	1. English 2. Spanish 3. Other Specify ___________ ACC1T					ACC1
2. What languages do you speak?	a. English b. Spanish c. Other Specify	1. Yes 1. Yes 1. Yes _____	2. No 2. No 2. No ACC2T	3. A little 3. A little 3. A little		ACC2A ACC2B ACC2C
3. Would you say that you use mostly English or mostly Spanish or about the same?	1. Only English 2. Only Spanish 3. Mostly English 4. Mostly Spanish 5. Both the same					ACC3
4. Do you know how to read English?	1. Yes 2. No 3. Partially (reason) ______________________					ACC4 ACC4T2
5. Do you know how to read Spanish?	1. Yes 2. No 3. Partially (reason) ______________________					ACC5 ACC5T
6. If YES or PARTIALLY to both previous questions: Which do you read better?	1. English 2. Spanish 3. Both equally					ACC6
7. Do you know how to write English?	1. Yes 2. No 3. Partially (reason) ______________________					ACC7 ACC7T2
8. Do you know how to write Spanish?	1. Yes 2. No 3. Partially (reason) ______________________					ACC8 ACC8T
9. If YES or PARTIALLY to both previous questions: Which do you write better?	1. English 2. Spanish 3. Both equally					ACC9
10. What language do you use:	Only Spanish	More Spanish than English	Both equally	More English than Spanish	Only English	NA
10A…for watching TV?	A. 1	2	3	4	5	ACC10A 6
10B…for reading newspapers/books?	B. 1	2	3	4	5	ACC10B 6
10C…for speaking with neighbors?	C. 1	2	3	4	5	ACC10C 6
10D…at work?	D. 1	2	3	4	5	ACC10D 6
10E…for listening to the radio?	E. 1	2	3	4	5	ACC10E 6
10F…with friends?	F. 1	2	3	4	5	ACC10F 6
10G…with family?	G. 1	2	3	4	5	ACC10G 6

Appendix B: Psychological Acculturation Score (PAS)

Question	Only w/PR	More w/PR than Americans	Same among PR and Americans	More w/PR than Americans	Only w/Americans
1. With which group of people do you feel you share most of your **beliefs** and **values**?	1	2	3	4	5
2. With which group of people do you **have the most in common**?	1	2	3	4	5
3. With which group of people do you feel **most comfortable**?	1	2	3	4	5
4. In your opinion, which group of people best **understands your ideas** (ways of thinking)?	1	2	3	4	5
5. Which culture do you feel **proud** to be a part of?	1	2	3	4	5
6. In what culture do you know **how things are done** and feel that **you can do them easily**?	1	2	3	4	5
7. In what culture do you feel confident that you **know how to act**?	1	2	3	4	5
8. In your opinion, which group of people do **you** understand best?	1	2	3	4	5
9. In what culture do you know **what is expected** of a person in various situations?	1	2	3	4	5
10. Which culture do you **know the most about** (for example: its history, traditions, and customs)?	1	2	3	4	5

Note: PR = Puerto Ricans.

Appendix C: Variables Used to Determine Diabetes Prevalence at Baseline

BPRHS stage	BPRHS variable	Type of variable	Diabetes diagnosis value/range	Variable use
Baseline	GLYHGB (glycosylated hemoglobin in serum)	Continuous	GLYHGB≥6.5%	Diabetes diagnosis, prevalence, management
Baseline	MANTIDB (use of anti-diabetes medication)	Dichotomous	0: “No” 1: “Yes”	Diabetes diagnosis, prevalence, management
Baseline	Q4GLYHGBMED2 (glycosilated hemoglobin and use of anti-diabetes medication)	Dichotomous	0: GLYHGB<7 and MANTIDB[a]=0 1: GLYHGB ≥7 or MANTIDB[a]=1	Diabetes diagnosis, prevalence, management

Appendix D: Variables Used to Determine Diabetes Prevalence at 2-Year and 5-Year Follow-Up

BPRHS stage	BPRHS variable	Type of variable	Diabetes diagnosis value/range	Variable use
2-year follow-up	GLYHGB _2YR (glycosylated hemoglobin in serum)	Continuous	GLYHGB_2YR≥6.5%	Diabetes diagnosis, prevalence, management
5-year follow-up	GLYHGB _5YR (glycosylated hemoglobin in serum)	Continuous	GLYHGB_5YR≥6.5%	Diabetes diagnosis, prevalence, management
2-year follow-up	MANTIDB_2YR (use of anti-diabetes medication)	Dichotomous	0: “No” 1: “Yes”	Diabetes diagnosis, prevalence, management
5-year follow-up	MANTIDB_5YR (use of anti-diabetes medication)	Dichotomous	0: “No” 1: “Yes”	Diabetes diagnosis, prevalence, management
2-year follow-up	Q4GLYHGBMED2_2YR (glycosilated hemoglobin and use of anti-diabetes medication)	Dichotomous	0: GLYHGB _2YR<7 and MANTIDB_2YR=0 1: GLYHGB _2YR≥7 or MANTIDB[a]_2YR=1	Diabetes diagnosis, prevalence, management
5-year follow-up	Q4GLYHGBMED2_5YR (glycosilated hemoglobin and use of anti-diabetes medication)	Dichotomous	0: GLYHGB _5YR<7 and MANTIDB[a]_5YR=0 1: GLYHGB _5YR≥7 or MANTIDB[a]_5YR=1	Diabetes diagnosis, prevalence, management

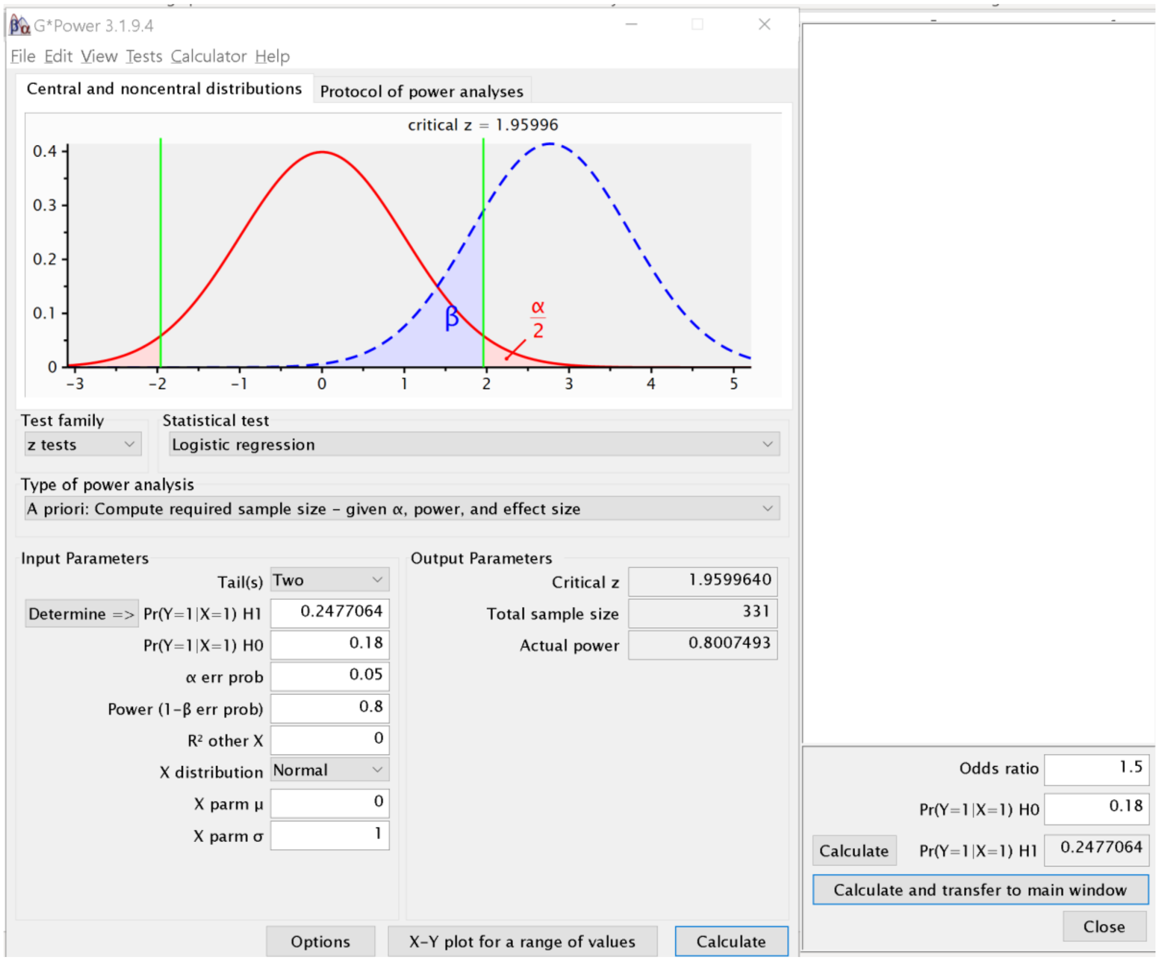
Appendix E: Physical Activity Score (ACT)

Last week, on a USUAL WEEKDAY (we will do the same for a WEEKEND DAY afterwards), how much time did you spend…:	Hours per day for a usual WEEKDAY: A	Hours per day for a usual WEEKEND day: B
1. SLEEPING AND LYING DOWN (even if not sleeping: night-time, sleep, naps and reclining) ASK EACH SEPARATELY, THEN SUM.	ACT1A	ACT1B
2. VIGOROUS ACTIVITY: (brisk walking, digging in the garden, strenuous sports, jogging, sustained swimming, chopping wood, heavy carpentry, bicycling on hills, etc.)	ACT2A	ACT2B
3. MODERATE ACTIVITY: (heavy housework, light sports, regular walking, dancing, yard work, painting, repairing, light carpentry, bicycling on level ground, etc.)	ACT3A	ACT3B
4. LIGHT ACTIVITY: (office work, light housework, driving a car, strolling, personal care, standing with little motion, etc.)	ACT4A	ACT4B
5. SITTING ACTIVITY: (eating, reading, watching TV, listening to the radio, etc.)	ACT5A	ACT5B
REPEAT QUESTIONS ABOVE FOR COLUMN B ANSWERS		
6. TOTAL: (NOTE: Total for each day should add up to 24 hours).	ACT6A	ACT6B
7. Would you say that during the past week you were less active than usual, more active, or about as active as usual?	1. Less active than usual 2. More active than usual 3. As active as usual	ACT7
8. How many <u>flights</u> of stairs do you climb up each day?	______ minutes	ACT8
9. How many city blocks or their equivalent do you walk each day?	______ blocks Or ______ minutes	ACT9 ACT9B
10. How much time do you spend watching TV each day?	______ hours	ACT10

Appendix F: Perceived Stress Score (PSS)

BPRHS variable	Categories	Variable (scale) questions	Variable formula
PSS (categorical variable)	"0" Never; "1" Almost never; "2" Every now and then; "3" Often; "4" Very often.	PSS1: "*how often have you been upset because of something that happened unexpectedly?"*; PSS2: "*how often have you felt that you were unable to control the important things in your life?"*; PSS3: "*how often have you felt nervous and stressed?"*; PSS4: "*how often have you dealt successfully with irritating life hassles?"*; PSS5: "*how often have you felt that you were effectively coping with important changes that were occurring in your life?"*; PSS6: "*how often have you felt confident about your ability to handle your personal problems?"*; PSS7: "*how often have you felt that things were going your way?"*; PSS8: "*how often have you found that you could not cope with all the things that you had to do?"*; PSS9: "*how often have you been able to control irritations in your life?"*; PSS10: "*how often have you felt that you were on top of things?"*; PSS11: "*how often have you been angered because of things that happened or were outside of your control?"*; PSS12: "*how often have you found yourself thinking about things that you have to accomplish?"*; PSS13: "*how often have you been able to control the way you spend your time?"*; PSS14: "*how often have you felt difficulties were piling up so high that you could not overcome them?"*. PSS4, PSS5, PSS6, PSS7, PSS9, PSS10, and PSS13 are scored in the reverse direction.	PSS = PSS1 + PSS2 + + PSS3 + PSS4 + PSS5 + PSS6 + PSS7 + PSS8 + PSS9 + PSS10 + PSS11 + PSS12 + PSS13 + PSS14
PSS_2YR (categorical variable)	"0" Never; "1" Almost never; "2" Every now and then; "3" Often; "4" Very often.	Same as PSS. PSS4_2YR, PSS5_2YR, PSS6_2YR, PSS7_2YR, PSS9_2YR, PSS10_2YR, and PSS13_2YR are scored in the reverse direction.	PSS_2YR = PSS1_2YR + PSS2_2YR + PSS3_2YR + PSS4_2YR + PSS5_2YR + PSS6_2YR + PSS7_2YR + PSS8_2YR + PSS9_2YR + PSS10_2YR + PSS11_2YR + PSS12_2YR + PSS13_2YR + PSS14_2YR
PSS_5YR (categorical variable)	"0" Never; "1" Almost never; "2" Every now and then; "3" Often; "4" Very often.	Same as PSS and PSS_2YR. PSS4_5YR, PSS5_5YR, PSS6_5YR, PSS7_5YR, PSS9_5YR, PSS10_5YR, and PSS13_5YR are scored in the reverse direction.	PSS_5YR = PSS1_5YR + PSS2_5YR + PSS3_5YR + PSS4_5YR + PSS5_5YR + PSS6_5YR + PSS7_5YR + PSS8_5YR + PSS9_5YR + PSS10_5YR + PSS11_5YR + PSS12_5YR + PSS13_5YR + PSS14_5YR
PSS_A (categorical variable)	Same as PSS variable.	Same as PSS variable with algorithm applied: using mean of PSS1-PSS14 if 7 or less answers are missing).	Same as PSS variable.
PSS_A_2YR (categorical variable)	Same as PSS_2YR variable.	Same as PSS variable with algorithm applied: using mean of PSS1_2YR-PSS14_2YR if 7 or less answers are missing).	Same as PSS_2YR variable.
PSS_A_5YR (categorical variable)	Same as PSS_5YR variable.	Same as PSS variable with algorithm applied: using mean of PSS1_5YR-PSS14_5YR if 7 or less answers are missing).	Same as PSS_5YR variable.

Appendix G: GPower Analysis of Study Sample Size



z tests – Logistic regression

Options: Large sample z-Test, Demidenko (2007)

Analysis: A priori: Compute required sample size

Input:

Tail(s)	=	Two
Pr(Y=1|X=1) H1	=	0.2477064

(Calculated based on an odds ratio of 1.5 since H/L have 50% greater chance of getting diabetes and H0 represents the reported 18% diabetes prevalence rate for Puerto Ricans) (CDC, 2019c; Schneiderman et al., 2014).

Pr(Y=1|X=1) H0	=	0.18
α err prob	=	0.05
Power (1–β err prob)	=	0.8
R^2 other X	=	0
X distribution	=	Normal
X parm μ	=	0

	X parm σ	=	1
Output:	Critical z	=	1.9599640
	Total sample size	=	331 (This is the number of needed participants)
	Actual power	=	0.8007493

Appendix H: Paired Samples *t* Test of Language Acculturation Scores Across Study Stages (Baseline, 2-Year Follow-Up, 5-Year Follow-Up)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Base: Language Acculturation Score	24.287	1253	22.388	.632
	2YR: Language Acculturation Score	22.992	1253	22.2843	.629
Pair 2	2YR: Language Acculturation Score	22.125	920	21.460	.707
	5YR: Language Acculturation Score	20.814	920	22.805	.751
Pair 3	Base: Language Acculturation Score	23.397	949	22.111	.717
	5YR: Language Acculturation Score	20.864	949	22.929	.744

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Base: Language Acculturation Score & 2YR: Language Acculturation Score	1253	.763	<.001
Pair 2	2YR: Language Acculturation Score & 5YR: Language Acculturation Score	920	.744	<.001
Pair 3	Base: Language Acculturation Score & 5YR: Language Acculturation Score	949	.756	<.001

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Base: Language Acculturation Score - 2YR: Language Acculturation Score	1.295	15.363	.434	.443	2.146	2.984	1252	.003
Pair 2	2YR: Language Acculturation Score - 5YR: Language Acculturation Score	1.311	15.878	.523	.283	2.338	2.505	919	.012
Pair 3	Base: Language Acculturation Score - 5YR: Language Acculturation Score	2.533	15.766	.511	1.529	3.537	4.951	948	<.001

Appendix I: Paired Samples *t* Test of Diabetes Prevalence Across Study Stages (Baseline, 2-Year Follow-Up, 5-Year Follow-Up)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	DV1_Dia_Prev	.50	1198	.500	.014
	DV1_Dia_Prev_2yr	.51	1198	.500	.014
Pair 2	DV1_Dia_Prev_2yr	.50	802	.500	.018
	DV1_Dia_Prev_5yr	.50	802	.500	.018
Pair 3	DV1_Dia_Prev	.49	824	.500	.017
	DV1_Dia_Prev_5yr	.50	824	.500	.017

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	DV1_Dia_Prev & DV1_Dia_Prev_2yr	1198	.703	< .001
Pair 2	DV1_Dia_Prev_2yr & DV1_Dia_Prev_5yr	802	.701	< .001
Pair 3	DV1_Dia_Prev & DV1_Dia_Prev_5yr	824	.648	< .001

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
	Diabetes prevalence	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Baseline – 2-year follow-up	-.008	.386	.011	-.030	.014	-.749	1197	.454
Pair 2	2-year follow-up - 2-year follow	.005	.387	.014	-.022	.032	.365	801	.715
Pair 3	Baseline – 5-year follow-up	-.013	.420	.015	-.042	.015	-.913	823	.361

Appendix J: Logistic Regression Analyses Between Language Acculturation Score and Diabetes Prevalence Across Three Study Stages (Baseline, 2-Year Follow-Up, and 5-Year Follow-Up)

Baseline

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1[a]	Baseline: Language Acculturation Score	-.010	.002	19.584	1	< .001	.990	.985	.994
	Constant	.272	.078	12.141	1	< .001	1.312		

a. Variable(s) entered on step 1: Baseline: Language Acculturation Score.

2-year follow-up

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1[a]	2YR: Language Acculturation Score	-.011	.003	17.206	1	< .001	.989	.984	.994
	Constant	.291	.083	12.219	1	< .001	1.338		

a. Variable(s) entered on step 1: 2YR: Language Acculturation Score.

5-year follow-up

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1[a]	5YR: Language Acculturation Score	-.008	.003	7.272	1	.007	.992	.986	.998
	Constant	.169	.094	3.253	1	.071	1.184		

a. Variable(s) entered on step 1: 5YR: Language Acculturation Score.

Appendix K: Logistic Regression Analysis Between Language Acculturation Score and Diabetes Prevalence Adjusting for Confounders at Baseline

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	77.770	8	< .001
	Block	77.770	8	< .001
	Model	77.770	8	< .001

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1900.454[a]	.053	.071

a. Estimation terminated at iteration number 3 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	7.687	8	.465

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1[a]	Age	.050	.008	35.929	1	< .001	1.051	1.034	1.069
	Male gender	.028	.122	.053	1	.817	1.029	.810	1.306
	At least some graduate school			3.586	4	.465			
	No schooling or less than 5th grade	.534	.432	1.525	1	.217	1.706	.731	3.980
	5th - 8th grade	.457	.426	1.154	1	.283	1.580	.686	3.640
	9th - 12th grade	.417	.416	1.008	1	.315	1.518	.672	3.429
	Some college or bachelor’s degree	.654	.429	2.329	1	.127	1.924	.830	4.458
	Years in the US	.009	.005	3.168	1	.075	1.009	.999	1.019
	Base: Language Acculturation Score	-.007	.003	5.039	1	.025	.993	.987	.999
	Constant	-3.477	.640	29.501	1	< .001	.031		

a. Variable(s) entered on step 1: Base: Age from date of birth to date of visit, Sex of Participant, Participant's Classified Education, Years in the US, Base: Language Acculturation Score.

Appendix L: Logistic Regression Analysis Between Language Acculturation Score and Healthy Eating Index at Baseline

Variables in the Equation

								95% C.I. for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	Base: Language Acculturation Score	-.012	.002	27.927	1	< .001	.988	.983	.992
	Constant	.367	.078	22.200	1	< .001	1.443		

a. Variable(s) entered on step 1: Base: Language Acculturation Score.

Appendix M: Logistic Regression Analysis Between Language Acculturation Score and Healthy Eating Index at Baseline Adjusting for Confounders

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	129.548	8	< .001
	Block	129.548	8	< .001
	Model	129.548	8	< .001

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1875.573[a]	.086	.114

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	4.320	8	.827

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B) Lower	Upper
Step 1[a]	Age	.061	.009	49.896	1	< .001	1.063	1.045	1.081
	Male gender	-.792	.124	41.033	1	< .001	.453	.355	.577
	At least some graduate school			8.150	4	.086			
	No schooling or less than 5th grade	-1.094	.454	5.800	1	.016	.335	.137	.816
	5th - 8th grade	-.940	.447	4.420	1	.036	.391	.163	.938
	9th - 12th grade	-.976	.436	5.010	1	.025	.377	.160	.886
	Some college or bachelor’s degree	-.691	.449	2.368	1	.124	.501	.208	1.208
	Years in the US	-.009	.005	2.930	1	.087	.991	.981	1.001
	Base: Language Acculturation Score	-.006	.003	3.820	1	.051	.994	.988	1.000
	Constant	-1.783	.647	7.592	1	.006	.168		

a. Variable(s) entered on step 1: Base: Age from date of birth to date of visit, Sex of Participant, Participant's Classified Education, Years in the US, Base: Language Acculturation Score.

Appendix N: Logistic Regression Analysis Between Language Acculturation Score and Being Active at Baseline, 2-Year Follow-Up, and 5-Year Follow-Up

Baseline

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B) Lower	Upper
Step 1[a]	Base: Language Acculturation Score	.018	.002	55.171	1	< .001	1.019	1.014	1.024
	Constant[b]	-.241	.078	9.524	1	.002	.786		

a. Variable(s) entered on step 1: Base: Language Acculturation Score.

b. Footnote

2-year follow-up

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B) Lower	Upper
Step 1[a]	2YR: Language Acculturation Score	.016	.003	37.430	1	< .001	1.016	1.011	1.021
	Constant	-.538	.084	41.136	1	.000	.584		

a. Variable(s) entered on step 1: 2YR: Language Acculturation Score.

5year follow-up

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B) Lower	Upper
Step 1[a]	5YR: Language Acculturation Score	.020	.003	42.222	1	.000	1.020	1.014	1.026
	Constant	-.446	.090	24.602	1	.000	.640		

a. Variable(s) entered on step 1: 5YR: Language Acculturation Score.

Appendix O: Logistic Regression Analysis Between Language Acculturation Score and Being Active Adjusting for Confounders at Baseline

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	97.344	8	< .001
	Block	97.344	8	< .001
	Model	97.344	8	< .001

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1888.435[a]	.065	.087

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	10.158	8	.254

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1[a]	Age	-.036	.008	19.339	1	<.001	.964	.949	.980
	Male gender	.266	.123	4.646	1	.031	1.305	1.024	1.662
	At least some graduate school			3.156	4	.532			
	No schooling or less than 5th grade	-.624	.475	1.725	1	.189	.536	.211	1.360
	5th - 8th grade	-.617	.470	1.723	1	.189	.540	.215	1.355
	9th - 12th grade	-.464	.461	1.012	1	.314	.629	.254	1.553
	Some college or bachelor’s degree	-.609	.474	1.651	1	.199	.544	.215	1.377
	Years in the US	-.008	.005	2.866	1	.090	.992	.982	1.001
	Base: Language Acculturation Score	.014	.003	21.311	1	<.001	1.014	1.008	1.021
	Constant	2.710	.664	16.661	1	<.001	15.027		

a. Variable(s) entered on step 1: Base: Age from date of birth to date of visit, Sex of Participant, Participant's Classified Education, Years in the US, Base: Language Acculturation Score.

Appendix P: Logistic Regression Analyses Between Language Acculturation Score and Taking Medication at Baseline, 2-Year Follow-Up, and 5-Year Follow-Up

Baseline

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1[a]	Base: Language Acculturation Score	-.009	.003	13.075	1	< .001	.991	.986	.996
	Constant	-.518	.080	41.742	1	< .001	.595		

a. Variable(s) entered on step 1: Base: Language Acculturation Score.

2-year follow-up

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1[a]	2YR: Language Acculturation Score	-.010	.003	12.729	1	< .001	.990	.985	.996
	Constant	-.341	.083	16.646	1	< .001	.711		

a. Variable(s) entered on step 1: 2YR: Language Acculturation Score.

5-year follow-up

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1[a]	5YR: Language Acculturation Score	-.008	.003	6.690	1	.010	.992	.986	.998
	Constant	-.219	.089	6.027	1	.014	.803		

a. Variable(s) entered on step 1: 5YR: Language Acculturation Score.

Appendix Q: Logistic Regression Analysis Between Language Acculturation Score and Taking Medication Adjusting for Confounders at Baseline

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	229.457	8	< .001
	Block	229.457	8	< .001
	Model	229.457	8	< .001

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1795.919[a]	.145	.194

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	12.365	8	.136

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B) Lower	Upper
Step 1[a]	Age	.007	.006	1.201	1	.273	1.007	.995	1.018
	Male gender	-.209	.124	2.849	1	.091	.811	.636	1.034
	At least some graduate school			26.070	4	< .001			
	No schooling or less than 5th grade	-.944	.335	7.963	1	.005	.389	.202	.749
	5th - 8th grade	-1.253	.319	15.414	1	< .001	.286	.153	.534
	9th - 12th grade	-1.341	.302	19.755	1	< .001	.262	.145	.473
	Some college or bachelor’s degree	-1.083	.326	11.032	1	.001	.339	.179	.641
	Years in the US	.015	.005	7.865	1	.005	1.015	1.004	1.025
	Base: Language Acculturation Score	-.013	.003	17.745	1	<.001	.987	.982	.993

a. Variable(s) entered on step 1: Base: Age from date of birth to date of visit, Sex of Participant, Participant's Classified Education, Years in the US, Base: Language Acculturation Score.

Appendix R: Logistic Regression Analysis Between Language Acculturation Score and Perceived Stress Score (Healthy Coping) at Baseline, 2-Year Follow-Up, and 5-Year Follow-Up

Baseline

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B) Lower	95% C.I. for EXP(B) Upper
Step 1[a]	Base: Language Acculturation Score	-.004	.002	3.000	1	.083	.996	.991	1.001
	Constant	.259	.077	11.170	1	.001	1.295		

a. Variable(s) entered on step 1: Base: Language Acculturation Score.

2-year follow-up

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B) Lower	95% C.I. for EXP(B) Upper
Step 1[a]	2YR: Language Acculturation Score	-.007	.003	7.178	1	.007	.993	.988	.998
	Constant	.317	.082	14.892	1	< .001	1.374		

a. Variable(s) entered on step 1: 2YR: Language Acculturation Score.

5-year follow-up

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B) Lower	95% C.I. for EXP(B) Upper
Step 1[a]	5YR: Language Acculturation Score	.017	.003	31.645	1	< .001	1.017	1.011	1.023
	Constant	-.253	.089	8.073	1	.004	.777		

a. Variable(s) entered on step 1: 5YR: Language Acculturation Score.

Appendix S: Logistic Regression Analysis Between Language Acculturation Score and Perceived Stress Score (Healthy Coping) Adjusting for Confounders at Baseline

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	58.515	8	< .001
	Block	58.515	8	< .001
	Model	58.515	8	< .001

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1942.952[a]	.040	.053

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	1.647	8	.990

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1[a]	Age	-.048	.008	33.197	1	< .001	.953	.938	.969
	Male gender	-.419	.120	12.318	1	< .001	.657	.520	.831
	At least some graduate school			10.849	4	.028			
	No schooling or less than 5th grade	1.121	.452	6.135	1	.013	3.067	1.264	7.446
	5th - 8th grade	1.105	.446	6.126	1	.013	3.018	1.258	7.238
	9th - 12th grade	1.034	.436	5.616	1	.018	2.813	1.196	6.619
	Some college or bachelor's degree	.672	.449	2.243	1	.134	1.959	.813	4.721
	Years in the US	.011	.005	4.819	1	.028	1.011	1.001	1.021
	Base: Language Acculturation Score	-.005	.003	3.151	1	.076	.995	.989	1.001
	Constant	1.760	.643	7.488	1	.006	5.811		

a. Variable(s) entered on step 1: Base: Age from date of birth to date of visit, Sex of Participant, Participant's Classified Education, Years in the US, Base: Language Acculturation Score.

Appendix T: Receiving Operating Characteristic (ROC) Curve as an Alternative Method to Test Goodness of Fit in Logistic Regression Analysis

Area Under the Curve

Study stage	Predictor variable	Outcome variable	Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
						Lower Bound	Upper Bound
Baseline	IV	DV1	.566	.015	<.001	.537	.596
Baseline	IV	DV2	.567	.015	<.001	.538	.596
Baseline	IV	DV3	.615	.015	<.001	.587	.644
Baseline	IV	DV4	.559	.016	<.001	.528	.590
Baseline	IV	DV5	.529	.015	.058	.499	.558
2-year follow-up	IV	DV1	.565	.016	<.001	.533	.597
2-year follow-up	IV	DV3	.583	.016	<.001	.551	.615
2-year follow-up	IV	DV4	.557	.017	.001	.524	.590
2-year follow-up	IV	DV5	.545	.016	.006	.513	.577
5-year follow-up	IV	DV1	.561	.020	.002	.522	.599
5-year follow-up	IV	DV3	.673	.018	<.001	.637	.709
5-year follow-up	IV	DV4	.550	.019	.009	.513	.588
5-year follow-up	IV	DV5	.627	.018	<.001	.591	.662

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5