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EXPLORING FACTORS INFLUENCING HEALTH PROMOTING BEHAVIORS AMONG LATINO IMMIGRANTS

by

Martin Mikell

A Dissertation Submitted in

Partial Fulfillment of the

Requirements for the Degree of

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ABSTRACT

EXPLORING FACTORS INFLUENCING HEALTH PROMOTING BEHAVIORS AMONG LATINO IMMIGRANTS

by

Martin Mikell

The University of Wisconsin-Milwaukee, 2017
Under the Supervision of Julia A. Snethen, PhD, RN

Latino immigrants may experience stress during acculturation to the U. S., which can influence their ability to engage in health-promoting behaviors, such as dietary intake and physical activity. Dietary intake and physical activity influence the prevention or development of pre-diabetes/Type 2 Diabetes (T2DM). The immigrant's ability to perform health-promoting behaviors can also be influenced by their perceptions of self-efficacy to engage in health-promoting behaviors. Limited information is available in the literature on effective strategies for decreasing stress during the acculturation process of Latino immigrants, while also increasing self-efficacy in health-promoting behaviors. The purpose of this study was to explore the associations between stress, acculturation, self-efficacy and the health-promoting behavior of physical activity in Latino adults. An adapted theoretical model based on the Health Promotion Model by Pender guided this study. Participants were adults (N = 195), 18 years or older, who were Latino immigrants. Participants completed 4 surveys with all questions in both Spanish and English, exploring perceptions of self-efficacy, exercise behavior, acculturation, and stress. Participants also completed pre-diabetes and demographic questionnaires. 61% of the respondents reported having at least one family member with T2DM. Having a family member with T2DM did not influence physical activity of the participants. Examination of physical activity levels by gender suggested that Latino men

reported engaging in significantly more vigorous physical activity when compared to Latino women ($p = 0.017$). There were significant correlations between walking behaviors and vigorous physical activity ($\chi^2 (137) = .380$, $p = .05$). Significant correlations were also found between walking and moderate physical activity ($\chi^2 (137) = .278$, $p = .01$). Among Latinos without prediabetes/T2DM, self-efficacy level and stress predicted physical activity. Among Latinos with pre-diabetes/T2DM, only age predicted physical activity. When the sample was stratified by pre-diabetes/T2DM status, self-efficacy remained a significant predictor of physical activity among Latinos without pre-diabetes/T2DM. However, among Latinos with pre-diabetes/T2DM, gender was the only significant predictor of physical activity and age no longer predicted physical activity. Assessing self-efficacy level may help recognize Latinos at risk for chronic illnesses, such as type 2 diabetes. Stress level can impact health-promoting behaviors among Latino immigrants and assessing stress is important for nurses to consider during interactions with Latinos in order to support health-promoting behaviors and lower risk for T2DM.

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DEDICATION

This dissertation is dedicated to my wife and children. You are my most important accomplishments, and by knowing you, I have been able to grow both as a nurse and as a person.

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LIST OF ABBREVIATIONS

ACSC	Ambulatory Care Sensitive Conditions
ACTH	Adrenocorticotropic Hormone
Acyl-CoA	Acyl-Coenzyme A
ADA	American Diabetes Association
AGE	Advanced Glycation End products
AgRP	Agouti-Related Peptide
Akt/ PKB	Akt/Protein Kinase B
AMP-K	AMP-Protein Activated Kinase
BMI	Body Mass Index
CAD	Coronary Artery Disease
CAR	Cortisol Awakening Response
CDC	Centers for Disease Control
CHC	Community Health Clinic
CNS	Central Nervous System
CRH	Corticotropic Releasing Hormone
CRP	C-Reactive Protein
CVD	Cardiovascular Disease
DPP	Diabetes Prevention Program
ER	Emergency Room
FFA	Free Fatty Acids
GAS	Generalized Adaption Syndrome
GC	Glucocorticoid receptors

GIP	Glucose-dependent Insulinotropic Polypeptide
GLP1	Glucagon-like Peptide 1
GLUT	Glucose Transporters
$HbA1_c$	Hemoglobin A1C
HNF-1α	Hepatocyte Nuclear Factor-α
HOMA-IR	Homeostatic Measurement-Insulin Resistance
HPA	Hypothalamic Pituitary Adrenal Axis
HPM	Pender’s Health Promotion Model
IFG	Impaired Fasting Glucose
IGT	Impaired Glucose Tolerance
IL-6	Interleukin- 6
IR	Insulin Resistance
IRAS	Insulin Resistance Atherosclerosis Study
IRS-1	Insulin Receptor Substrate -1
IRS-2	Insulin Receptor Substrate -2
LC-NE	Locus Ceruleus-Norepinephrine System
LHA	Lateral Hypothalamic Area
LTPA	Leisure Time Physical Activity
MetS	Metabolic Syndrome
MODY	Maturity Onset Diabetes in the Youth
NHANES	The National Health and Nutrition Examination Survey
NHW	Non-Hispanic White
NO	Nitric Oxide

NPY	Neuropeptide Y
OGTT	Oral Glucose Tolerance Test
PA	Physical Activity
PCMH	Patient Centered Medical Home
PI3K	Phosphatidylinositol-3 Kinase
PPARγ	Proxisome Proliferators-activated Receptors
PTSD	Post-Traumatic Stress Disorder
RNA	Ribonucleic Acid
ROS	Reactive Oxygen Species
SES	Socio-economic Status
S_I	Insulin Sensitivity
sICAM-1	Soluble Intracellular Adhesion Molecule -1
sVCAM-2	Soluble Intracellular Adhesion Molecule - 2
T2DM	Type 2 Diabetes Mellitus
TNF- α	Tumor Necrosis Factor - alpha
VMN	Ventromedial Hypothalamic Nucleus
WAT	White Adipose Tissue
WHO	World Health Organization
WHR	Waist Hip Ratio

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encouraged their children to succeed, but allowed us to find our own level. They taught us about the importance of education, and that education started at the kitchen table. I would not be who I am today without my siblings, who lent a supportive ear when I needed it.

CHAPTER ONE

Introduction

Health promotion and disease prevention have been the focus of nurses since the time of Florence Nightingale (Kagan, Smith, Cowling III, & Chinn, 2010), and continues to the present time (Vincent, 2009). Chronic conditions, as a result of lifestyle behaviors, affected nearly 30.9 million US adults in 2009, with significant increases in diabetes prevalence from 2002-2009 (Ford, 2013). The U.S. Centers for Disease Control (2014) projects that T2DM affects 29.1 million people, with 21 million people actually diagnosed and another 8.1 million people unaware of their diabetes. T2DM can lead to cardiovascular disease (Díaz-Apodaca, Ebrahim, McCormack, De Cosío, & Ruiz-Holguín, 2010; Kaplan, Aviram, & Hayek, 2012), placing individuals at greater risk for developing blindness, (American Diabetes Association, 2013) and premature death.

Diabetes Mellitus is a chronic health condition that directly affects glucose metabolism, with Type 2 Diabetes Mellitus (T2DM) being the most common endocrine disorder. Insulin is an endocrine hormone that allows a person's cells to use glucose for energy. T2DM is diagnosed when glucose cannot enter into a person's cells because the body's secretion of insulin is not great enough to meet their body's metabolic demands, or their cells become resistant to insulin. If a person's body develops a decreased sensitivity to insulin or their pancreas is unable to produce enough insulin, glucose molecules will gradually accumulate outside of the cells. As the level of extracellular blood sugar starts to rise, the person becomes hyperglycemic, and the elevated glucose levels could potentially become life threatening, causing the individual to become comatose and die.

Latinos are the largest and fastest growing minority population in the United States and are reported to be at increased risk for developing T2DM due to characteristics such as (a) genetic influences, (b) cultural factors, (c) limited access to healthcare services, (d) and health-promoting behaviors (Amirehsani, 2010; Casper, Harrolle, & Kelley, 2013; Kohlbry & Nies, 2009). Genetic factors can partly determine an individual's risk of developing T2DM (Díaz-Apodaca et al., 2010; Norris & Rich, 2012). Previous research suggested that Latinos were genetically predisposed to developing T2DM due to (a) a higher prevalence of insulin resistance, (b) decreased insulin secretion post-prandially and (c) elevated fasting insulin levels (Bastarrachea et al., 2007; Goran, Walker, & Allayee, 2012; Kommoju & Reddy, 2011). However, genetic factors alone could not be responsible for the rapid increase in prevalence of T2DM within the Latino community (Malecki, 2005).

Cultural perceptions of weight are a factor to consider, as many within the Latino community perceive an overweight person as a healthy person (Caballero, 2007; Guendelman, Ritterman□Weintraub, Fernald, & Kaufer□Horwitz, 2011). Cultural perspectives can also vary related to gender, as Latino males perceived that a muscular figure was more healthy when compared to a more lean one (Yanover & Thompson, 2010). Yet, Latino women were more likely to report feeling fat, (Gillen & Lefkowitz, 2011), while at the same time expressing less fear of becoming obese (Caballero, 2007). Research has demonstrated that cultural perceptions of weight may not be consistent with objective weight category data (Gillen & Lefkowitz, 2011; Jacobi, Taylor, & Fante, 2014).

Culturally, Latino adults may not make lifestyle changes due to not having the extended family members to help share the workload of the home (Mikell, Snethen, & Castro, 2016). The absence of family leads to fewer adults available to share the work of the household, such as

grocery shopping or watching the children (Castro, Shaibi, & Boehm-Smith, 2009). Additionally, it is important to understand that conceptualization of lifestyle changes may vary within cultural groups. An example might be related to physical activity (physical activity), as perceptions among Latinos that light housework or energy expended at work constitutes physical activity may lower incentives to be active when barriers to physical activity are absent (Castro et al., 2009; Kohlbry & Nies, 2009). Research has suggested that Latino males were more physically active than females, though their levels of physical activity were still below that of non-Hispanic white males (Casper et al., 2013; Ickes & Sharma, 2012). Among Latino women, investigators have demonstrated they have low levels of physical activity, which places them at risk for developing obesity (Ickes & Sharma, 2012; Martyn-Nemeth, Vitale, & Cowger, 2010; Mier, Medina, & Ory, 2007).

Cultural practices among the Latino community have been noted in food preferences and reported levels of physical activity. Newly immigrated Latinos, who retained their home country cultural food preferences, demonstrated greater fruit and vegetable intake, suggesting that established cultural practices can be health-promoting (Ghaddar, Brown, Pagán, & Díaz, 2010). On the other hand, newly immigrated Latinos were also observed to have lower levels of physical activity, which can increase the risk of developing T2DM (Barrera Jr, Toobert, Strycker, & Osuna, 2012; Ghaddar et al., 2010).

Despite adequate levels of physical activity, other non-modifiable factors may be contributing to T2DM development in the Latino immigrant, such as access to health care (Derose, Escarce, & Lurie, 2007). Latinos have reported limited access to healthcare services due to immigration status, lack of health insurance or language issues (Becerra, Androff, Messing, Castillo, & Cimino, 2015; Shi, Tsai, Higgins, & Lebrun, 2009). Limited healthcare

access adversely impacts health promotion and illness prevention, and the ability to be screened for health risks (e.g. a fasting blood sugar), and the early detection of T2DM (Schwartz & Artiga, 2007). Additionally, limited healthcare access can prevent Latinos from receiving the treatment they need, such as medications, or follow-up care to ensure their treatment is effective (Anand, Adams, & Zuckerman, 2010; Documet & Sharma, 2004).

Research among Latinos suggests that while Latino adults understand that T2DM is a serious illness, use of health-promoting behaviors such as physical activity has not increased (Sutherland, Weiler, Bond, Simonson, & Reis, 2012). The health-promoting behavior of physical activity is defined as any form of aerobic exercise that uses large muscle groups and that results in sustained increases in heart rate (Colberg et al., 2010). The health-promoting behavior of physical activity serves as an important way for people to lower their risk of developing obesity, and the benefits from the health-promoting behavior of physical activity have been observed with as little as 30 minutes of weekly vigorous physical activity (Hamer & Stamatakis, 2012; Lyerly et al., 2009). Latinos report that a desire to be healthy, plus anticipated physical benefits from physical activity, were important reasons to engage in physical activity (Casper et al., 2013). However, Latinos report time constraints, as well as family obligations, frequently limit physical activity efforts. Structural constraints, such as a lack of safe and affordable facilities to engage in physical activity, were also reported as barriers to increasing physical activity level (Martyn-Nemeth et al., 2010).

Health-promoting behaviors are an important way persons in the Latino community can positively impact the health of adults and their family members (Vincent, 2009). Health-promoting behaviors, such as physical activity, improve mental well-being and promote sleep (Kroll, Keller, Scholz, & Perren, 2011). Health-promoting behaviors not only enhance an

individual's current health status, but also provide benefits throughout the lifespan. Older adults who participate in health-promoting behaviors demonstrate an ability to engage in community activities and spend less on medical costs (Stark, Chase, & DeYoung, 2010). However, older Latinos reported that having diabetes was a source of embarrassment and a cause of awkward social situations, and were less likely to adhere to recommendations from health care providers or engage in health-promoting behaviors (Haltiwanger, 2012). Older Latinos may require greater social support from family and community members in managing T2DM and using the health-promoting behavior of physical activity to lower T2DM risk development (Ickes & Sharma, 2012).

Questions remain as to what are possible barriers among Latino immigrants that limit efforts at health-promoting activities, such as physical activity. Sedentary behaviors amongst Latinos, such as viewing television can increase the level of inflammatory cells in the body and put an individual at risk for chronic illness (Hamer & Stamatakis, 2012). Health care providers frequently recommend that persons increase frequency of physical activity as both a way to lose excess weight, and to lower the risk of chronic illnesses (Hughes, Leung, & Naus, 2008). Efforts are needed to minimize barriers to the health-promoting behavior of physical activity and motivate persons within the Latino community to engage in the health-promoting behavior of physical activity, particularly in individuals at risk for developing preventable illnesses.

Pender's Theory of Health Promotion

The Health Promotion Model (HPM) is a health and wellness framework designed by Dr. Nola Pender. Important constructs in the model are prior related behavior, perceived self-efficacy, and interpersonal influences (Agazio & Buckley, 2010; Barnes & Lu, 2012). The HPM posits that as self-efficacy in a given behavior increases, the likelihood that a given behavior will

continue also increases (Pender, 2011). The HPM also states that self-efficacy is inversely related to barriers to change, so that when self-efficacy is high, barriers to performing health behaviors decrease (Polit & Beck, 2008). According to the HPM, individual characteristics and prior related behavior can strengthen illness prevention efforts (Pender, 2011). Prior health related behaviors are an individual's earlier experiences and are one of the best predictors of future behaviors (Pender, 2011). Using the HPM as the framework, nurses can design effective interventions to enhance an individual's self-efficacy in an attempt to decrease the risk of developing a chronic illness.

Statement of the Purpose

Research among Latino populations suggest that in order to minimize the threat of developing T2DM, lifestyle changes such as participating in the health-promoting behavior of physical activity are needed (Bopp, Fallon, & Marquez, 2011; Otero, Fong, Papineau, Thorne, & Zanetti, 2011). Reports from previous research studies reported that Latino adults are not routinely engaging in the health-promoting behavior of physical activity (Casper et al., 2013; Rosal, Borg, Bodenlos, Tellez, & Ockene, 2011). Identifying why individuals within the Latino community don't engage in health-promoting behaviors could provide greater insight into future efforts to prevent the development of T2DM amongst Latino adults. The purpose of this study is to explore whether there is an association between acculturation, self-efficacy, stress and the health-promoting behavior of physical activity in Latino adults. A secondary aim is to identify whether there are differences in the health-promoting behavior of physical activity amongst Latino adults with pre-diabetes/T2DM and Latino adults without pre-diabetes/T2DM.

Research Questions

1) How do Latino adults engage in health-promoting behaviors related to physical activity?

2) What are the differences in self-efficacy, stress and the health-promoting behavior of physical activity between Latino adults with pre-diabetes/Type 2 Diabetes Mellitus and Latino adults without pre-diabetes/T2DM?

3) What is the relationship between acculturation, self-efficacy, stress and the health-promoting behavior of physical activity among Latino adults?

4) What is the relationship between acculturation, self-efficacy, stress and the health-promoting behavior of physical activity amongst Latino adults with pre-diabetes/T2DM and Latino adults without pre-diabetes/T2DM?

Definition of Terms

Acculturation

Acculturation is conceptually defined as the process by which persons are adapting to a new language and culture, while being separated from their family. Acculturation will be operationally defined by participant responses to Acculturation Rating Scale for Mexican Americans-II (ARSMA-II).

The Health-Promoting Behavior of Physical Activity

The health-promoting behavior of physical activity is conceptually defined as any physical activity that increases heart rate. The health-promoting behavior of physical activity will be operationally defined by participant responses to the International Physical Activity Questionnaire (I-PAQ).

Pre-diabetes/T2DM:

The conceptual definition of pre-diabetes/T2DM is an individual who was informed by a health care provider that they have pre-diabetes or have T2DM. The operational definition of

pre-diabetes/T2DM is a participant who self-reports of having pre-diabetes, at risk of developing T2DM, or currently has T2DM.

Self-Efficacy

Self-efficacy is conceptually defined as the self-confidence that one has in their ability to change health behaviors when facing barriers or when in challenging situations. Self-efficacy will be operationally defined by responses to the Diabetes Empowerment Scale-modified version (DES) (Hackworth et al., 2007).

Stress

Chronically elevated stress levels are associated with increased risk of cardiovascular disease and T2DM (DeFronzo, 2009). Chronically elevated stress levels will be conceptually defined as a negative emotional state with a physiological response, which is generated by perceived threats and taxing demands. Stress will be operationally defined by responses to the Perceived Stress Scale (PSS) (González-Ramírez, Rodríguez-Ayán, & Hernández, 2013).

Justification and Significance

Currently, there is limited knowledge about adult Latinos with pre-diabetes/T2DM living in the community and the health-promoting behavior of physical activity. Increasing physical activity is one modifiable lifestyle factor that Latinos can participate in to lower their risk of developing T2DM (Masters, Liese, Haffner, Wagenknecht, & Hanley, 2010). Increased physical activity has also demonstrated to be an effective tool to manage weight gain, as well as in the prevention of obesity, which is another important way to lower T2DM risk (Jackson, 2009). Latinos are a population that is particularly vulnerable to T2DM due to social, economic and language barriers. Stressors endured by immigrants during acculturation to the U.S. include being more likely to live alone and a fear of deportation, which may be a contributing factor to

diminished levels of the health-promoting behavior of physical activity (Arbona et al., 2010). Another barrier to physical activity is unsafe neighborhoods, as well as structural barriers such as poor sidewalks, which limit access to safe places to walk (Mier et al., 2007). Perceptions of T2DM risk factors among Latinos may be interfering with the health-promoting behavior of physical activity. Understanding the relationships between acculturation, self-efficacy and stress among Latinos with pre-diabetes/T2DM may clarify how Latinos perceive T2DM risk. Self-efficacy is another important way to increase regular physical activity, such as enhancing motivation and increasing diabetes knowledge, so that individuals are more confident in setting and attaining physical activity goals (Herder et al., 2009). Among Latinos, self-efficacy has been observed as an important way to improve T2DM management behaviors, as well as to increase the health-promoting behavior of physical activity in Latinos at risk for T2DM (Ickes & Sharma, 2012; Sarkar, Fisher, & Schillinger, 2006).

Summary

The results from this research will lend support for the need to address diabetes risk factors and foster adoption of healthy behaviors. Health promotion behaviors need to be practiced daily, and interventions that foster physical activity and healthy dietary intake are the first steps toward optimal health. Using the HPM as a theoretical framework will provide a new perspective regarding associations between acculturation, the adoption of health-promoting behaviors and perceived stress among Latinos.

CHAPTER TWO

Introduction

Blood sugar in the body is tightly regulated by the nervous, endocrine and digestive systems. Alterations in any of these regulatory metabolic systems can result in illness. In Type 2 Diabetes Mellitus (T2DM), alterations occur in glucose regulation, resulting in increased levels of blood sugar. As blood sugar increases, persons can become dehydrated, and if the blood sugar does not return to a normal level, they can become comatose. T2DM not only affects blood sugar metabolism, but affects protein and fat metabolism as well. T2DM develops slowly, and persons can have an elevated blood sugar, but not be diagnosed with T2DM. Persons with an elevated blood sugar, who are not diabetic, are sometimes referred to as pre-diabetic, and are at increased risk for T2DM. Obesity, stress, ethnicity and genetic pre-disposition can also increase risk of developing T2DM.

Due to the increasing incidence of T2DM, diabetes prevention has become one of the most salient public health initiatives in the United States. T2DM is a leading cause of morbidity and mortality, the leading cause of blindness and end-stage renal disease (American Diabetes Association, 2013). Modifiable and non-modifiable characteristics can increase the risk of developing diabetes in at-risk populations. Health-promoting behaviors, such as participation in physical activity and a healthy diet, are important ways to reduce the risk of developing T2DM. When barriers to physical activity are present, health-promoting behaviors decrease, resulting in disparities in health outcomes. Disparities in health outcomes have been observed in ethnic minorities, such as Latinos. Latinos are at risk for disparities in health outcomes due to limited English language skills and limited access to health care services. Screening tests for T2DM in

at-risk populations help raise disease awareness, and culturally relevant interventions are needed to promote physical activity and possibly delay the onset of chronic illness.

Conceptual Framework for Behavior Change

Pender's Health Promotion Model (HPM)

Pender's Health Promotion Model (HPM) is a theoretical framework frequently used to examine engagement in health-promoting behaviors. Individuals manage to participate in health-promoting activities despite multiple barriers, and the HPM can serve as a lens to see how individuals persevere. The HPM posits that individuals have an active role in improving their health and can overcome barriers in the process (Alkhalaileh, Khaled, Baker, & Bond, 2011). The HPM is important to nursing because of its emphasis on health promotion and its multidimensional view of people, with the goal being to keep the person, family or community in an optimal state of health.

A nursing theory, the HPM helps describe and explain relationships between people and phenomena. The HPM predicts interactions among individual characteristics, behavior-specific cognitions, and outcome behaviors, which can benefit individuals, families, and communities. Research suggests that many chronic illnesses are closely tied to low levels of physical activity and poor diet, while health-promoting behaviors can lower risk (Brink, 2009; Kohlbry & Nies, 2009; Padden, Connors, Posey, Ricciardi, & Agazio, 2013). The HPM was successful among diverse populations to explain illness and also in the design of interventions to promote health (Agazio & Buckley, 2010; Eshah, Bond, & Froelicher, 2010; Ho, Berggren, & Dahlborg□ Lyckhage, 2010).

Pender's HPM is based on the health behavior theories of expectancy value theory and social cognitive theory. Expectancy value theory suggests that people are motivated to work

toward goals that they value. People are also more likely to invest effort in goals toward a desired outcome (Peterson & Bredow, 2009). Social Cognitive theory, designed by Alfred Bandura, is based on the concept of self-efficacy (Bandura, 1982). Self-efficacy is defined as an individual's perceived capability to organize and execute a particular action (Agazio & Buckley, 2010). Bandura suggests that as an individual's self-efficacy in a particular behavior increases, the more likely the individual will engage in that behavior, despite encountering barriers to do so (Peterson & Bredow, 2009).

The HPM assumes that people seek to create living conditions in which they can express their health potential. Individuals have the capacity for reflective self-awareness, according to the HPM, and they want to grow and attempt to balance behavior change with stability (Pender, 2011). Another assumption of the HPM is that people regulate their own health behavior, and, with either individual or group support, can sustain newly-adopted health behaviors. However, adoption of new behaviors is also dependent on the interpersonal environment of the individual. According to Pender, health professionals are part of the interpersonal environment that influences individual behavior and health promotion through social re-enforcement (Pender, 2011).

Mediators are variables that intervene between the dependent and independent variable and help to explain why a relationship exists (Polit & Beck, 2008). The HPM posits that the greater the self-efficacy of the individual, the more likely the behavior will be maintained despite the presence of barriers (Pender, Murdaugh, & Parsons, 2011). Modeling behaviors and social support also are important theoretical propositions to the HPM. When others model the given health behavior or expect the behavior to occur, people are more likely to commit to the healthy

behavior. Families, peers, and health care providers are important influences that can either increase or decrease health-promoting behaviors (Pender, 2011).

Studies Using the HPM

In an integrative review of the HPM, key variables supported theoretical assumptions. HPM variables, such as self-efficacy, benefits and barriers, and prior experiences, directly and indirectly influence health-promoting behaviors (Alkhalaileh et al., 2011). The HPM is adaptable and appropriate for use in vulnerable populations, as seen by the previous use by nursing researchers examining diverse populations, such as Native Americans, Latinos, women serving in the military (Agazio & Buckley, 2010; Alkhalaileh et al., 2011; Barnes & Lu, 2012; Padden et al., 2013).

Previous researchers studying Latinos have used the HPM to examine health-promoting behaviors, specifically defined as breastfeeding and taking medications, illustrating that health-promoting behaviors are measurable and consistent with the model (Alkhalaileh et al., 2011; Barnes & Lu, 2012; Schlickau & Wilson, 2005). In an integrative literature review by Schlickau and Wilson (2005), the researchers examined breastfeeding as a health-promoting behavior among Latino women. Previous research with breastfeeding behavior, as well as personal factors, such as level of acculturation, predicted health-promoting behaviors. Latino women reported that breastfeeding was easier (benefits to action), and that breastfeeding enhanced mother-child attachment (activity-related affect). In the 25 reviewed studies, health-promoting behaviors consistently supported the theory and influenced the outcomes behaviors (Schlickau & Wilson, 2005).

In a study by Barnes and Lu (2012), researchers used the HPM to understand the experiences of Latinos living with hypertension. The researchers wanted to examine medication

adherence, clinic visits and self-management practices for hypertension. Study participants were recruited from two community health clinics (CHCs), and all study participants were being treated for hypertension for at least one year. Barnes and Lu (2012) reported that perceived barriers to buying and taking medications included lack of understanding of the severity of illness and cost of the medication. Researchers also reported low levels of self-efficacy in following dietary recommendations for hypertension and in using blood pressure cuffs at home for disease management (Barnes & Lu, 2012).

Chilton, Hu and Wallace (2006) examined relationships between diabetes knowledge and a health-promoting lifestyle among Latinos. The researchers studied participants from two predominantly Latino church congregations. Participants rated their health as good, and only 10 percent reported they had diabetes. Researchers observed that the constructs of the HPM were supported by study findings. Participants who had lower income levels had lower levels of perceived control over their health, suggesting that income was a perceived barrier to physical activity. Personal factors, such as education, directly influenced health-promoting behaviors. As education levels increased, an increase in health-promoting activities was seen, as well as a greater understanding of diabetes (Chilton, Hu, & Wallace, 2006).

In the review by Kohlbry and Nies (2010), the study authors evaluated the literature on factors that affected activity levels in older Hispanic women. The authors examined three theoretical frameworks associated with physical activity, including the HPM. Similar to Barnes and Lu (2012), Kohlbry and Nies reported that barriers to physical activity, interpersonal influences, competing demands and personal factors predicted health-promoting behaviors. The authors posited that cultural factors, such as acculturation, were important to consider, because low acculturation correlated with less leisure time physical activity (Kohlbry & Nies, 2009).

Interventions that incorporated salsa dancing and exercise classes in Spanish, and that took place in community organizations, demonstrated success in promoting physical activity among Latinos, especially when social support was also present (Kohlbry & Nies, 2009).

The Importance of Diabetes Prevention

Increased Attention Towards Diabetes

Several nations have carried out prevalence studies similar to the United States' National Health and Nutrition Examination Survey (NHANES) in an attempt to measure public health. Some examples of international cross-sectional research were the Korean Health and Nutrition Examination Survey, the China National Diabetes and Metabolic Disorder Study, the Finnish Diabetes Prevention Study and the French Nutrition and Health Survey (Wild, Roglic, Green, Sicree, & King, 2004). Prevalence of diagnosed diabetes varied slightly-4.6 percent in France (Bonaldi et al., 2011), 7.4 percent in Korea (Chung & Pérez-Escamilla, 2009), and 12.9 percent in the United States (Geiss et al., 2010). While data do not demonstrate a significant difference in the diabetes prevalence rate among nations, developing nations of India, China and Indonesia are forecast to have an enormous diabetes burden in 2030 (Wild et al., 2004). The increase in diabetes prevalence in the U.S. has prompted heightened attention to diabetes prevention efforts (Sherwin & Jastreboff, 2012).

National efforts to reduce T2DM incidence has lead to interest in T2DM prevention among high risk groups, such as persons with impaired glucose tolerance. Recommendations that physical activity and weight loss delayed T2DM were not supported by randomized controlled trials until the findings of the Diabetes Prevention Program Research Group were published (Knowler et al., 1995). These findings suggested that lifestyle interventions were more efficacious than oral anti-diabetic medications in lowering diabetes risk. The study results

were ground-breaking and generated substantial interest in further expansion of diabetes prevention programs. Subsequent research supported the importance of physical activity plus intensive dietary interventions as a way to lower risk of diabetes development when compared to standard recommendations (Boltri et al., 2008; Jackson, 2009; Orozco et al., 2008; Ruggiero, Oros, & Choi, 2011).

Increased Costs of Health Care

The expense of diabetes-related care and medications is becoming a significant financial burden to both communities and families. The cost of caring for persons with T2DM dramatically affects our health system, due to more people living with the disease and significant expenses that result from long term illness management (LaMonte, Blair, & Church, 2005a). Direct costs to people with diabetes, as measured in work loss, disability and premature mortality, are as high as $69 billion annually (Center for Disease Control and Prevention, 2014). Some estimates of direct medical costs of care are approximately $174 billion dollars annually (Sherwin & Jastreboff, 2012). In 2011, there were approximately 175,000 emergency room visits by people suffering from hyperglycemic crises. When the average emergency room visit costs approximately $1,500, the potential costs of emergency room visits for diabetes related complications has become a large financial burden on the healthcare system (Ahn et al., 2013).

The cost of healthcare insurance has become an increasingly common financial burden for many individuals and families, as deductibles from employer-sponsored healthcare plans continue to increase. From 2001 to 2004, a family who had employer-sponsored healthcare plans experienced an increase in health-related expenses of $553.00, or a 21 percent rise. In individuals with private, non-employer group coverage, the increase in healthcare insurance cost was more dramatic, from 39 percent in 2001 to 52.7 percent in 2004 (Banthin, Cunningham, &

Bernard, 2008). High out-of-pocket expenses also were reported by poor and low-income persons, however, public insurance plan recipients pay the lowest share of health insurance at 13.5 percent. Researchers suggest that healthcare insurance costs, as well as diabetes-related medication costs, will continue to outpace growth in personal incomes, thereby increasing the financial burdens placed on families (Banthin et al., 2008; Sarpong, Bernard, & Miller, 2012).

Focus Turns to Prediabetes

Previous research suggested that populations at risk for T2DM needed targeted interventions to delay the onset of T2DM, particularly in individuals with pre-diabetes (Chen & Lin, 2010; Gallivan, Brown, Greenberg, & Clark, 2009; Otero et al., 2011; Troughton et al., 2008). Some individuals develop either impaired fasting plasma glucose (IFG), impaired glucose tolerance (IGT), or have both IFG and IGT, and are referred to as having pre-diabetes. People are identified as having IFG if they have a fasting blood glucose level between 100 mg/dl to 125 mg/dl. People are identified as having IGT if they have blood glucose levels between 140 mg/dl and 199 mg/dl after an oral glucose tolerance test (OGTT) (American Diabetes Association, 2013). Even with slightly elevated levels of blood glucose in the circulation, researchers suggested that damage to the vascular circulation was occurring due to the presence of excess glucose, and subsequent inflammatory changes (Chu et al., 2012; Genc et al., 2011). Subtle changes in inflammation in the body releases chemicals that can lead to increased risk of developing T2DM, heart disease and stroke, even in persons without known disease (Wisconsin Diabetes Prevention and Control Program, 2011). Despite the risk of developing diabetes, many persons remain unaware of their risk factors and ways to slow disease development (Geiss et al., 2010).

Many pre-diabetic persons are not aware they have pre-diabetes because they lack symptoms associated with diabetes, such as polyuria or polydipsia (Chen & Lin, 2010). In the U.S. National Health and Nutrition Examination Survey (NHANES) study, only a small percentage of U.S. adults with pre-diabetes were aware they were at high-risk of developing T2DM, and approximately only half began behavioral changes to lower their risk (Geiss et al., 2010). Researchers estimate that 30% of persons with pre-diabetes develop diabetes (Parikh et al., 2010), thus, awareness of T2DM risk becomes essential, along with early intervention. However, physicians frequently report lack of training in nutrition and counseling, as well as a continued focus on medical aspects of care, as challenges in managing persons with pre-diabetes (McTigue, Conroy, Bigi, Murphy, & McNeil, 2009)

Metabolic Syndrome

People with slightly elevated blood sugar, but not high enough to be diagnosed as diabetic, have developed one of the characteristics of Metabolic Syndrome (MetS). Those with MetS also are at increased risk of developing cardiovascular disease and T2DM (Abdul-Ghani & DeFronzo, 2010; Arbona et al., 2010). A clinical diagnosis, MetS is comprised of the following characteristics: (a) elevated fasting blood glucose; (b) increased waist circumference (WC); (c) low levels of high density lipoproteins; (d) elevated triglycerides; and (e) hypertension (Norris & Rich, 2012). In individuals with MetS, blood sugar becomes chronically elevated, and the hyperglycemic state results in damage to many organs, micro- and macro-blood vessels, and nervous tissues (Abdul-Ghani & DeFronzo, 2010; Bays et al., 2008; DeFronzo, 2009; Genc et al., 2011).

Previous research suggests the prevalence of MetS is rising, in conjunction with increasing rates of obesity and lack of physical activity, suggesting an association may exist

between lifestyle and MetS risk (Abraham, Brunner, Eriksson, & Robertson, 2007; Bays et al., 2008; Holme, Tonstad, Sogaard, Larsen, & Haheim, 2007). The development of MetS differs slightly from prediabetes in that prevalence of MetS increases with age and obesity, with approximately one-third of overweight and obese persons in the U.S. manifesting symptoms of MetS. While people with MetS and prediabetes can be overweight, MetS is more closely associated with central obesity which is more pathogenic (Abraham et al., 2007). Central obesity and T2DM are strongly correlated, as opposed to peripheral obesity, which does not appear to be as harmful (Boulbou et al., 2005; Capurso & Capurso, 2012; Genc et al., 2011). With MetS being a potential precursor to T2DM, in addition to cardiovascular disease, interventions aimed at increasing physical activity and controlling weight are important health-promoting strategies to consider (Capurso & Capurso, 2012; Holme et al., 2007).

Diabetes Prevention Programs (DPP)

The Diabetes Prevention Program was a randomized clinical trial to examine strategies to delay the onset of T2DM in high risk individuals. The program was carried out in 27 clinical centers in the U.S. from 1996 to 2001 with over 3,000 participants (Diabetes Prevention Program Research Group, 1999). The research goals of the Diabetes Prevention Program were to compare the efficacy of three intervention arms; an intensive lifestyle intervention compared to standard lifestyle recommendations combined with either metformin or placebo. Secondary study goals were to examine the group differences in the development of cardiovascular disease and changes in clinical and biological markers (Diabetes Prevention Program Research Group, 1999). The outcome goals for participants in the intensive lifestyle intervention were to achieve and to maintain at least a 7 percent reduction in body weight. Participants would achieve weight loss through healthy eating and maintain at least 150 minutes/week of physical activity through

moderately intensive activities. Participants were recruited over a two and a half year period and followed for an additional three and a half years. The research approach was similar to diabetes prevention programs that took place in Europe and China and demonstrated significant reductions in diabetes risk development (Diabetes Prevention Program Research Group, 1999; Eriksson & Lindgärde, 1991).

Knowler et al. (2002) reported that between the lifestyle modification, medication and placebo groups, the lifestyle modification group demonstrated the greatest increase in physical activity. The lifestyle group also demonstrated the largest amount of weight loss, which is particularly important when the program's aim is diabetes prevention (Knowler et al., 1995). In a systematic review of weight loss interventions, the DPP demonstrated a marked mean weight change of 5.5 kg at follow-up of 2.8 years (Norris et al., 2009). The lifestyle intervention group reduced their incidence of diabetes by 58 percent when compared to the placebo group, and by one-third in the metformin group, when compared to the placebo group (Knowler et al., 2002; Knowler et al., 1995). The DPP was more effective at reducing diabetes risk than similar studies conducted in Europe and Asia (Pan et al., 1997; Tuomilehto et al., 2001). Recent attempts by researchers to translate the DPP into the community health centers (CHC) also met DPP outcomes, however, in vulnerable populations who face barriers to health-promoting activities (Chakkalakal et al., 2012; Davis-Smith et al., 2007; Ruggiero et al., 2011).

Previous studies have translated the DPP from the hospital, into community health centers and churches to reach out to groups with limited access to health care (Davis-Smith et al., 2007; Gallivan et al., 2009; Ruggiero et al., 2011; Seidel, Powell, Zgibor, Siminerio, & Piatt, 2008; Whittemore, 2011). The systematic review by Whittemore (2011) demonstrated that the DPP model could be effectively translated and applied to community based settings. Whittemore

(2011) examined studies which took place in four distinct settings: a) hospital based locations, b) primary care, c) community settings, and d) work or church settings. The original DPP goals were feasible; however, the researcher reported when comparing diversity of participants a trend became apparent. In settings with less diversity (i.e., hospitals), a greater amount of weight loss was observed. In settings with greater diversity (community setting and churches), less weight loss was seen. Differences in program outcomes may be due to the use of contracts and participation fees charged by hospitals to the participants, typically ranging from $250 to $800. Church and community health centers offered free program services (Whittemore et al., 2009).

Work and church settings, followed by community settings, demonstrated high levels of participant diversity, suggesting that the DPP is feasible outside of the hospital-based programs. Low levels of attrition among participants also were observed in CHCs, suggesting that DPPs may be a missing part of health promotion in at-risk communities (Whittemore, 2011). Implementation of hospital based DPP programs used health care providers (doctors, diabetic educators, nurses, dietitians) to conduct the educational classes. In work or church settings, community health workers administered the DPP effectively (Whittemore, 2011). One program used community peer educators and demonstrated that peer educators were effective and many times less expensive than health care professionals (Perez-Escamilla, Hromi-Fiedler, Vega-Lopez, Bermudez-Millan, & Segura-Perez, 2008). Clinic populations reflected greater heterogeneity, but demonstrated lower amounts of weight loss when compared to hospital settings. As implementation of the DPP continued, it became evident that modifications to the original program would be needed to ensure efficacy among the diverse populations who use CHCs to access health care services.

Modifications to the DPP

Modifications to the initial DPP were needed to ensure the DPP curriculum would be culturally relevant. Ruggiero et al. (2011), mimicked the goals of the DPP, and conducted a diabetes risk reduction intervention with at-risk Latinos. The study participants were mostly young females (mean age was 37.8 years), entirely Latino, of low socio-economic status, with low educational levels, and obese. The researchers used the Transtheoretical Model to measure health behavior change, adding a culturally relevant aspect: community health workers, trained by researchers, worked extensively with program participants. Program supplemental materials and implementation of small groups were targeted at low literacy levels and settings were specifically chosen to facilitate participation. After the intervention, significant differences were observed in reported amount of fat intake, increased consumption of fruits and vegetables, and increased physical activity (Ruggiero et al., 2011). High participation levels were further attributed to the cultural focus of the intervention, and the use of community health workers (promotoras) to deliver the program to the community participants.

Modifications to the length of time of the DPP study also were needed to make the program feasible in CHCs. In one study, the original core curriculum of 16 weeks, followed by six monthly group follow-up visits, was adapted by the researchers to a group-based program with a reduction in the overall program length (Amundson et al., 2009). The adaptions by the authors demonstrated the DPP was efficacious, despite the reduced participation time. After the 16 core sessions were completed, men averaged 280 minutes per week of physical activity, and women reported 219 minutes per week. Significant increases among male and female participants were observed post-intervention when compared to the start of the program (Amundson et al., 2009). There also were statistically significant reductions in mean weight loss

among older and younger participants, as well as improvements in risk factors for diabetes and cardiovascular disease (Amundson et al., 2009).

Despite demonstrated success in the prevention of T2DM, challenges exist when comparing DPP interventions. One challenge continues to be that physical activity results are not consistently reported in publications (Eaglehouse, Kramer, Rockette-Wagner, Arena, & Kriska, 2015). In a systematic review by Eaglehouse et al. (2015), of 57 DPP translation studies, 82 percent of the studies included a physical activity goal, but only 60 percent of the studies reported results of the intervention efficacy on physical activity outcomes. Lacking pre-intervention physical activity level data made it difficult to measure whether the intervention actually increased physical activity levels (Eaglehouse et al., 2015). The absence of a standardized psychometric tool to measure physical activity levels among the DPP translation studies also made study effectiveness comparisons problematic. The CDC has now established standardized guidelines for DPP curriculum content and requirements for program recognition in an effort to quantify physical activity results as well as weight loss (Centers for Disease Control Prevention, 2011).

Normal Glucose Metabolism

Glucose Production

The continual supply of glucose is vitally important to all body cells and is closely regulated by the endocrine system. Blood glucose concentrations are normally maintained between 70 and 100 mg/dl (Sherwood, 2007). Depending on the metabolic needs of the body, ingested nutrients are either used or stored in muscle, liver or adipose tissue. The primary site for glucose production is the liver, with small amounts being contributed by the kidneys, and the gut (Sandoval, Obici, & Seeley, 2009). Hepatic glucose production is determined by rate of

glycogenolysis (breakdown of glycogen) and glucose synthesis of non-glucose precursors, such as glycerol, amino acids and lactate (Sandoval et al., 2009; Sherwood, 2007). Skeletal muscle can utilize both glucose and FFA for fuel, and during times of fasting, muscle tissue uses FFA exclusively to function (Abdul-Ghani & DeFronzo, 2010). Having different forms of energy available to support homeostasis is important, particularly since the body requires energy to support cell functions when supplies are abundant and in times of fasting.

Glucose Storage (Muscle/Fat/Liver Activity)

After eating a mixed meal, approximately one third of glucose goes to the liver, one third goes to the skeletal muscle and adipose tissue, and the remaining third goes to insulin independent tissues in the central nervous system (CNS) (DeFronzo, 2009; Sandoval et al., 2009). The body's storage mechanisms work as follows: excess glucose is stored as glycogen in the liver and muscle, excess free fatty acids (FFAs) are stored as triglycerides, and excess amino acids are converted to glucose and FFAs which are then stored as triglycerides (Bays et al., 2008; DeFronzo, 2004b).

Insulin Function and Receptor Signals

The pancreatic beta cells secrete insulin and the concentration of insulin in the blood is a reflection of the current metabolic requirements (Baynes & Dominiczak, 2014). Insulin is an anabolic hormone, and after eating, insulin secretion occurs in response to the increase in blood glucose concentration. Insulin decreases blood sugar by enhancing glucose transport into cells, stimulating glycogenesis, inhibiting glycogenolysis, and decreasing hepatic glucose output (DeFronzo, 2004b; DeFronzo, 2009; Sherwood, 2007). Insulin facilitates entry of free fatty acids into adipose tissues, and inhibits lipolysis. Insulin also inhibits protein degradation, and promotes transport of amino acids from the blood into muscles and other tissues (Almomani,

2011; Calle, 2011; Sherwood, 2007). After ingestion of a meal, the beta cells of the pancreas are stimulated by free fatty acid (FFA) levels in the blood, and under the influence of insulin, dietary FFAs are converted to acyl-CoA derivatives. Acyl-CoA enhances insulin secretion from the beta cells, as well as stimulates calcium levels to increase inside the beta cells, further enhancing insulin secretion (DeFronzo, 2004a, 2004b).

Cells are activated by insulin to increase uptake of glucose via insulin receptors and glucose transporters (GLUT) (Abdul-Ghani & DeFronzo, 2010). Insulin acts by binding to the insulin receptor (IR) on the cell membrane, which initiates a phosphorylation cascade (Benito, 2011; Ryu, Park, Ma, Zhang, & Lee, 2011; Tanti & Jager, 2009). IRS-1 is a key molecule in insulin signaling and is involved in signal transduction (Webber, 2010). Insulin binds to the alpha ($\propto$) subunit of the insulin receptor (IRS-1), which then activates the tyrosine kinase in the beta (β) subunit within the cell (Sun et al., 1991). In the sentinel work by Sun et al. (1991), it was first suggested that IRS-1 migrated as a phospho-protein during insulin stimulation. Once the IRS-1 migration occurred on the cell membrane, a cascade of reactions took place, and then the glucose receptor became activated. IRS-1 contains many potential phosphorylation sites, with some phosphorylation sites having either a positive or a negative effect on IRS-1 function (Benito, 2011; Tanti & Jager, 2009).

When the insulin molecule binds to its receptor, one of the binding sites becomes activated via tyrosine phosphorylation and then binds with IRS-1 and IRS-2 as an alternate substrate (Ryu et al., 2011). The activated IRS signal then binds and activates phosphatidylinositol 3-Kinase (PI3K) (Capurso & Capurso, 2012). PI3K is an enzyme that appears to play a role in stimulation of insulin transport and activation of glycogen synthase. Once PI3K phosphorylation occurs, the insulin signal is relayed to Akt/PKB, a serine/threonine

kinase, which is then activated (Capurso & Capurso, 2012). The phosphorylation of Akt/PKB then translocates the GLUT-4 receptor from inside the cell to the plasma membrane, and glucose transport into the cell takes place (Henriksen, Diamond-Stanic, & Marchionne, 2011). Once inside the cell, the glucose molecule is phosphorylated by glucokinase (Baynes & Dominiczak, 2014).

Glucose Transporters

There are six known transporters, but only GLUT-4 responds to insulin (Sherwood, 2007). In normoglycemic individuals, GLUT-4 is stored in vesicles within insulin-dependent cells, and in cells that do not require insulin to uptake glucose, like the central nervous system (Lin et al., 2011). GLUT-4 is a transport molecule that is sensitive to insulin and increased numbers of transport molecules are observed in the cell membrane following insulin secretion. GLUT-4 is found extensively in muscle and adipose tissues (Sherwood, 2007), and serves as the primary site for glucose uptake on the cell membrane. GLUT-1 receptors are predominantly located in insulin-independent tissues, such as the brain and erythrocytes; however, it is also found in muscle cells. GLUT-2 is found mostly in the liver and functions as a glucose sensor (DeFronzo, 2004b; Sherwood, 2007).

Counter-Regulatory Hormones

Counter-regulatory hormones play an important role in insulin secretion and glucose homeostasis. Counter-regulatory hormones act against the actions of insulin, and promote hyperglycemia (Baynes & Dominiczak, 2014). Under times of physical activity or stress, hormones such as cortisol, epinephrine, and growth hormone act to (a) increase availability of glucose, (b) to increase the amount of fatty acids in the blood, and (c) to decrease amino acid uptake (Almomani, 2011; Sherwood, 2007).

Glucagon

Glucagon is a catabolic hormone that directly affects carbohydrate, fat and protein synthesis to increase availability of energy. Glucagon secretion occurs when the body's metabolic demands exceed the current energy supply (Baynes & Dominiczak, 2014). Secreted by the alpha cells of the pancreas, glucagon raises hepatic glucose production by promoting glycogenolysis and gluconeogenesis. Glucagon output is stimulated by a drop in free fatty acid concentration and promotes fat breakdown to increase available energy (Sherwood, 2007). Glucagon also increases the availability of proteins via inhibition of protein synthesis and increased degradation of hepatic protein, which are used as glucose pre-cursors (Sherwood, 2007).

Leptin

Leptin is a hormone that is synthesized by and released from adipocytes and plays an important role in appetite regulation (Ata et al., 2010). Leptin is an anorexigenic hormone, which promotes satiety and decreases food intake. Serum leptin levels rise after eating and fall rapidly during fasting, helping to maintain body weight (Sumithran et al., 2011). Leptin is known to cross the blood-brain barrier and provides the brain with information regarding energy status (Kawakami et al., 2008). In a previous study, researchers noted that obese people demonstrated higher levels of leptin and researchers suggested that obese people may be resistant to the effects of leptin, which can further exacerbate obesity (Ata et al., 2010). Researchers also posited that leptin may reduce HPA activity and possibly ameliorate depressive behaviors and improve mood (Akter et al., 2014).

Leptin is known to influence glucose metabolism through activation of leptin receptors in the arcuate nucleus of the hypothalamus (Al-Daghri et al., 2007; Sandoval et al., 2009; Weigle et al., 1997; Yokaichiya, Galembeck, Torres, Da Silva, & de Araujo, 2008). Researchers demonstrated that some of the physiologic actions of leptin reduce food intake by inhibiting several appetite stimulators, such as AMP-activated protein kinase (AMP-K). AMP-K activity, an important fuel sensor activated during low energy levels, is suppressed by leptin and suppression of AMP-K is necessary for weight loss (Minokoshi et al., 2004; Sandoval et al., 2009). Leptin also attenuates the activity of neuropeptide Y (NPY) and agouti-related peptide (AgRP), which are potent appetite stimulators, which reduce food intake (Sandoval et al., 2009).

Leptin concentrations are positively correlated with weight loss (Garcia et al., 2006); however, changes in leptin levels did not influence food intake after acute exercise (Douglas et al., 2015). Researchers suggest that leptin alters glucose levels via two physiologic pathways: it reduces food intake and increases energy expenditure in individuals, indirectly improving insulin sensitivity. Leptin also indirectly improves insulin sensitivity through induction of fatty acid oxidation; however, researchers have not yet discovered a way to make leptin therapy feasible for commercial use in weight loss (Yokaichiya et al., 2008).

Ghrelin

Ghrelin is another hormone that can alter food intake. Ghrelin, a peptide hormone, affects appetite and energy homeostasis and may provide an explanation for increasing obesity prevalence. Ghrelin is an orexigenic molecule, meaning that it stimulates appetite and may influence body weight. Ghrelin is secreted by the stomach and has been linked to energy states, psychological stress, and mood status (Chuang & Zigman, 2010). Ghrelin is found in either an acylated or a deacylated form, however, the acylated form of ghrelin is biologically active and is

commonly used in analysis (Garcia et al., 2006). Ghrelin secretion increases during weight loss. Ghrelin also enhances the release of norepinephrine, a hormone which is normally secreted during the fight or flight response (Ata et al., 2010). The increased norepinephrine during stress contributes to an increased level of awareness; however, increased food intake also occurs, which might contribute to obesity in chronically stressed individuals (Kawakami et al., 2008). Ghrelin also may have an effect on food preferences, such as sweetened sodas, and may explain how some food cravings occur (Avena, Rada, & Hoebel, 2008).

Stressful conditions can affect ghrelin secretion. When rats were exposed to chronically stressful conditions, ghrelin levels remained significantly elevated, even after the stressful conditions were removed (Chuang & Zigman, 2010). What surprised researchers was that ghrelin levels were checked later in the same rats under non-stressful conditions, and ghrelin levels remained elevated (Chuang & Zigman, 2010). Ghrelin also may possess an anti-depressant effect. To demonstrate ghrelin’s effect on mood, researchers kept rats on a low calorie diet, and the same rats were later subjected to a forced swim test. Rats that received an injection of ghrelin into the intracerebroventricular region of the brain were compared to controls and observed during the swim test. Rats that received ghrelin were more active in water, suggesting that ghrelin had a calming effect during stress exposure (Chuang & Zigman, 2010).

Another area of interest is the effect of ghrelin on reward seeking behaviors and addiction. Food preferences can activate the nervous system and influence food preferences. Brain regions, such as the pre-frontal cortex, the nucleus accumbens, and the ventral tegmental area are the reward and motivation centers. Motivation centers influence a person’s desire for addictive substances like drugs, alcohol, and high-calorie foods (Page et al., 2011). Something as simple as a picture of a calorie-dense food can prompt people to eat, especially if they are

slightly hungry. When healthy, non-obese participants were shown pictures of high-calorie foods, researchers observed that brain areas around the thalamus, hypothalamus, and the pre-frontal cortex were the most active (Page et al., 2011). However, in people with higher BMIs, there was decreased prefrontal activity, suggesting that obese persons may have altered satiety cues and may overeat.

Orexins

Orexin neurons play a role in eating behaviors and when stimulated, food intake increases. Orexin neurons (also referred to as hypocretins) have extensive projections in the hypothalamus, specifically in the lateral hypothalamus. Orexins play a role in sleep-wake states as well as in the desire for palatable foods (Dugovic et al., 2009; Sakurai, 2007). Research suggests that orexin neurons also influence reward-seeking behaviors, such as preference for alcohol and other addictive drugs (Aston-Jones et al., 2010; Harris & Aston-Jones, 2006). Researchers are focusing on orexins as a possible factor in the rise of obesity and possibly as a contributor in sugar consumption (Avena et al., 2008).

There are two types of orexin receptors, orexin-1 and orexin-2, and both contribute to energy homeostasis. Orexin-2 receptors are activated during times of increased arousal, and orexin-1 receptors are associated with reward-seeking behaviors, such as in repeated alcohol and drug intake (Anderson, Becker, Adams, Jesudason, & Rorick-Kehn, 2014). Researchers used selective blockage of Orexin 1 & 2 neurons to demonstrate the unique function of orexin receptors. When researchers blocked the orexin-2 receptors, experimental rats were observed to be less alert. Researchers observed the rat's behavior mimicked narcolepsy, an illness characterized by excessive daytime sleepiness (Dugovic et al., 2009; Sakurai, 2007). Mice with a genetic deletion of orexin-1 neurons did not display any preference for morphine, a drug

known for its addictive properties (Aston-Jones et al., 2010). When both orexin-1 and orexin-2 were blocked, alcohol intake decreased, however, combined blockage also lowered water intake, suggesting that selective receptor blockage may provide more targeted results in alcohol binge behaviors (Anderson et al., 2014).

Neurotransmitters, such as dopamine and acetylcholine, are molecules secreted by the nervous system during pleasure-seeking behaviors, as well as during chronic illicit drug use (Avena et al., 2008). The concept of addiction, also referred to as dependence, is characterized by compulsive, and occasionally, uncontrollable behaviors that take place at the expense of other activities (Avena et al., 2008). Research suggests that a desire for certain foods, such as sugar containing items, can be similar to drug addiction. The same neurotransmitters released in drug addiction were secreted in people who abstained from sugar and later intermittently engaged in sugar binge-eating (Avena et al., 2008).

Orexin-1 receptors are stimulated during sugar intake and share the same neurological pathways as dopamine and acetylcholine, suggesting that sugar could potentially be addictive. To illustrate sugar addiction, researchers chemically deactivated orexin-1 receptors in mice and witnessed a reduction in overall sugar intake (Alcaraz-Iborra & Cubero, 2015). To demonstrate sugar binge-eating, researchers studied two groups of mice that had an unlimited access to food. The experimental group was injected with a known orexin-1 receptor agonist, and the control group received saline. Mice that received the receptor agonist completely ignored satiety signals and consumed significantly more food compared to mice that were injected with saline (Zheng, Patterson, & Berthoud, 2007).

Epinephrine

The stress response to trauma, surgery or burns involves the release of catecholamines, which are anti-insulinic hormones (Baynes & Dominiczak, 2014). A common catecholamine, epinephrine is part of the stress response to a perceived threat. Epinephrine is secreted by the adrenal glands under the control of the sympathetic nervous system and results in physiologic changes, such as increased heart rate, vasoconstriction and increased respiratory rate (Sherwood, 2007). Epinephrine, along with glucagon, stimulates glycogenolysis and gluconeogenesis, which leads to increased availability of glucose in the tissues (Baynes & Dominiczak, 2014). Epinephrine has a uniform effect throughout the body, and when the systemic stress response does not respond to the restraining mechanisms within the body, illness can develop (Selye, 1956; Sherwood, 2007).

Growth Hormone

Growth hormone is essential for growth, but also influences other metabolic tissues not related to growth (Sherwood, 2007). Growth hormone increases the amount of energy available to the cells by encouraging breakdown of triglycerides, and regulation of body fat distribution and vascular health (Stanley & Grinspoon, 2015). The mobilization of fatty acids and decreased glucose uptake ensures that the nervous system (especially the brain) has an adequate glucose supply. During times of low energy availability, the muscle tissue transitions to fatty acids as a source of energy, and growth hormone increases fatty acid release from adipose tissues (Sherwood, 2007). Alterations in the secretion of growth hormone are seen as a possible contributor to visceral fat accumulation (Stanley & Grinspoon, 2015).

Growth hormone excess also can increase the risk of hypertension, T2DM, dyslipidemia and endothelial dysfunction, as witnessed in people with acromegaly, a syndrome of excess growth hormone secretion (Lin et al., 2012). Growth hormone deficiency is also associated with

increases in cardiovascular risk, particularly in persons with increased visceral obesity (Adam et al., 2010; Stanley & Grinspoon, 2015). When a recombinant growth hormone was administered to people with known deficiencies, decreases in visceral adipose tissue and C-reactive protein levels were observed (Lin et al., 2012). Due to the adverse effects on glucose concentration, however, growth hormone replacement is not a feasible option in the management of increasing visceral obesity or cardiovascular risk reduction (Stanley & Grinspoon, 2015).

Cortisol

Cortisol is a glucocorticoid hormone secreted by the adrenal cortex in response to physiologic, psychological, or physical stressors. In the circulation, cortisol is catabolic to adipose tissue, resulting in increased lipolysis, and is anabolic in the liver, causing increased glucose release (Bays et al., 2008). Cortisol also stimulates gluconeogenesis, inhibits glucose uptake, and stimulates protein degradation, resulting in more energy available for the individual to resist stress (Sherwood, 2007). Cortisol is secreted by the adrenal glands, under the stimulus of adrenocorticotropic hormone (ACTH). When adrenocorticotropic hormone (ACTH) secretion decreases due to a signal from the anterior pituitary gland, cortisol secretion also decreases (Hill, Zack, Battaglini, Viru, & Hackney, 2008).

Normal cortisol secretion follows a diurnal rhythm, peaking shortly after awakening and decreasing throughout the day, with a small post-prandial increase in the early afternoon (Gallagher-Thompson et al., 2006). Cortisol secretion is tightly regulated, and when cortisol secretion is poorly controlled, illnesses can occur. An example of an illness due to high levels of cortisol in the circulation is Cushing Syndrome. Cushing Syndrome results in excessive gluconeogenesis and abdominal obesity (McEwen, 2006; Sherwood, 2007), and also results in re-distribution of fat stores (Groschl, 2008). Low levels of cortisol present in the circulation can

lead to Addison's Disease, and results in a poor response to stress and low blood glucose (Sherwood, 2007). Previous researchers have also investigated cortisol as a possible contributing factor in insulin insensitivity, especially in persons who are overweight (Walker, 2006).

Central Nervous System Role in Glucose Regulation

Nutrient Sensors

GLP1 and GIP.

The way the body responds to glucose depends on how glucose enters the body. When glucose is administered intravenously, there is an increase in splanchnic (liver plus the GI tract) glucose uptake. However, when glucose is administered orally, the splanchnic glucose uptake is markedly enhanced (DeFronzo, 2004b). The enhanced glucose response to oral ingestion is due to the effect of incretins, Glucose-dependent insulinotropic polypeptide (GIP) and glucagon-like peptide 1 (GLP1). These hormones are secreted from the gut and stimulate an insulin response after eating (Sandoval et al., 2009). The splanchnic tissues are responsible for removal of 30 to 40 percent of ingested glucose, and the actions of the incretins cause a more gradual rise in blood glucose concentration (DeFronzo, 2004b). GLP1 is considered to be the more potent enhancer of insulin secretion, and in T2DM individuals who receive an intravenous solution of GLP1, post-prandial insulin secretion is enhanced (DeFronzo, 2004b; DeFronzo, 2009).

Hypothalamus.

The hypothalamus is a neuroendocrine organ located at the base of the brain and has a direct connection to another important endocrine gland, the pituitary gland. The two glands together comprise the Hypothalamic-Pituitary Axis (HPA). The HPA has been an area of research interest because of the long-reaching effects of hormones on the body's metabolic, digestive, and nervous systems (Sherwood, 2007). The hypothalamus is divided into separate

areas, but there is overlap among the regions. The hypothalamic nuclei involved in homeostasis include the paraventricular nucleus, the dorsomedial nucleus, the ventromedial hypothalamus, and the lateral hypothalamus (Sandoval et al., 2009). Previous research designated two hypothalamic centers as having important and opposite effects on food intake-the ventromedial hypothalamic nucleus (VMN) and the lateral hypothalamic area (LHA) (Page et al., 2011). The VMN is referred to as a satiety center, and the LHA as a hunger center. The VMN contains glucose-sensing neurons, and, in mice models, VMN knockout animals gradually develop glucose intolerance without gaining weight, suggesting that alterations in the CNS can promote IGT (Paranjape et al., 2011). Two central components of the hypothalamus are corticotrophin-releasing hormone (CRH) and the locus ceruleus-norepinephrine (LC-NE)/autonomic nervous system, which are activated during the adaptation response, particularly in bouts of acute stress and depression (Kawakami et al., 2008; Sandoval et al., 2009)

Locus ceruleus/norepinephrine system.

The HPA and the sympathetic system are in close proximity to one another and subsequently stimulate each other during a stress response. The sympathetic system consists of the paraventricular nuclei of the hypothalamus and the noradrenergic neurons of the locus ceruleus/norepinephrine nuclei of the brain stem (Chrousos, 2000; McEwen, 2006). When an individual perceives stress, the paraventricular nucleus is activated and releases Corticotropic Releasing Hormone (CRH), which stimulates the release of adrenocorticotropic hormone (ACTH) from the anterior pituitary (McEwen, 2006). ACTH subsequently stimulates the adrenal glands to secrete cortisol, as well as reduces food intake and body weight (Kawakami et al., 2008). The HPA axis regulates the secretion of adrenal cortisol, and cortisol can indirectly affect the diverse homeostatic mechanisms in the body (McEwen, 2006). Researchers have speculated

that abnormal cortisol secretion may be an independent risk factor for obesity, diabetes and cardiovascular disease (McEwen, 2006).

Arcuate nucleus.

The arcuate nucleus, located in the floor of the third ventricle in the brain, is a collection of neuronal bodies in close proximity to neurons that influence appetite and possibly alertness. The interaction between leptin and the arcuate nucleus is hypothesized to be important for energy balance and glucose metabolism (Leshan, Bjornholm, Munzberg, & Myers, 2006). The arcuate nucleus responds to the effects of leptin and receives input from circulating leptin and insulin, and forms a neuronal response to maintain energy levels (Laplante & Sabatini, 2012). The arcuate nucleus can influence appetite through the actions of powerful appetite stimulants neuropeptide Y (NPY) and agoti-related peptide (agRP) (Cason et al., 2010), which also can indirectly enhance the state of arousal. The arcuate nucleus is involved in wakefulness, and researchers suggest that arcuate neurons influence wakefulness through the action of orexin neurons (Cason et al., 2010). This heightened state of arousal may aid in the search for food, however, may also be contributing to the rise of obesity in the U.S.

Pathophysiology of Diabetes Mellitus Type 2 (T2DM)

T2DM affects energy homeostasis in the body, as well as the storage of carbohydrates, proteins and fats. Carbohydrate metabolism is altered due to the absence of insulin's regulatory effects. In people with T2DM, post-prandial glucose and hepatic glucose production not inhibited by insulin result, and excess glucose overflows into the urine. The excess in glucose results in increased water loss in the urine. The person begins to urinate more frequently, and without intervention, dehydration results (Sherwood, 2007). As individuals become dehydrated,

they attempt to compensate by drinking water, which increases urinary frequency. Gradually, the brain cells cannot tolerate the changes in cellular water volumes, and the individual experiences changes in mental status and death (Cydulka & Maloney Jr, 2002).

T2DM affects fat metabolism and storage by increasing the amount of free fatty acids (FFA) in the circulation. While the majority of people with diabetes are overweight, both lean and obese persons with T2DM have elevations of FFAs that are not diminished by insulin (DeFronzo, 2004b). Chronically elevated FFAs levels can result in insulin resistance and may impair insulin secretion due to the secretion of inflammatory adipokines (Abdul-Ghani & DeFronzo, 2010; Inzucchi & Sherwin, 2011; Olefsky & Glass, 2010), which are pathogenic and contribute to atherosclerosis (Bays et al., 2008). Diabetes mellitus affects protein metabolism by resulting in a shift from an anabolic state to a catabolic state, raising amino acid blood levels. The increase in amino acids (via lipolysis) also can increase gluconeogenesis by the liver, worsening the individual's hyperglycemia (Abdul-Ghani & DeFronzo, 2010; DeFronzo, 2004a).

Lipotoxicity

FFAs are secreted from adipose tissue, and this type of dyslipidemia is a significant risk factor for T2DM development (Olefsky & Glass, 2010). Free fatty acids (FFAs) affect blood glucose levels either by altering transduction of insulin signaling or by affecting beta cells directly, creating an insulin resistance state (DeFronzo, 2009; Olefsky & Glass, 2010). Increased levels of FFAs are referred to as lipotoxicity, and the pathogenic nature of the FFAs depends on which type of adipose tissue secreted the FFAs. FFAs released by abdominal adipocytes are more insulin-resistant than visceral adipose tissue and promote dyslipidemia and disrupt metabolic processes (Bays et al., 2008; DeFronzo, 2009). Elevated free fatty acids interfere with the uptake of glucose by the muscle tissue and provide the liver with energy to continue

gluconeogenesis, which worsens hyperglycemia (Brunetti, Chiefari, & Foti, 2014). The increase in FFAs also results in a decreased ability of the skeletal muscle to dispose of glucose, an increased rate of lipolysis, and impaired insulin signaling (Bays et al., 2008). The excess free fatty acid concentrations in the circulation lead to increased FFA concentrations within the beta cells, subsequent inhibition of insulin ribonucleic acid (RNA) expression, and a reduction of glucose-stimulated insulin release (DeFronzo, 2009). FFAs also attenuate the appetite lowering actions of leptin, suggesting that lipotoxicity not only induces an insulin-resistant state, but possibly a leptin-resistant state, as well (Bays et al., 2008).

Lipotoxicity often occurs in individuals during the progression from impaired glucose tolerance to T2DM (DeFronzo, 2009). Inside the beta cells of the pancreas, FFAs are converted to acyl-CoA and increased concentrations of acyl-CoA in the beta cells result in increased nitric oxide production. Increased nitric oxide production increases expression of the pro-inflammatory cytokines interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF- α), which further impair beta cell function (Abdul-Ghani & DeFronzo, 2010; DeFronzo, 2004a; DeFronzo, 2009). Build-up of FFAs in muscle and fat cells further contributes to insulin insensitivity and insulin resistance, and increased triglyceride levels have been observed in muscle tissue biopsies of obese, normoglycemic individuals (Abdul-Ghani & DeFronzo, 2010). However, when the concentration of FFA was reduced in T2DM individuals, an improvement in the insulin sensitivity of muscle tissue was observed (Abdul-Ghani & DeFronzo, 2010; DeFronzo, 2004c; DeFronzo, 2009).

Glucotoxicity

Alterations in insulin sensitivity can lead to elevated levels of glucose in the plasma, which can contribute to glucotoxicity (DeFronzo, 2004a). The concept of glucotoxicity suggests

that the gradual decline in beta cell function is a result of either chronic elevation of plasma glucose, or that elevated levels of glucose are toxic to the beta cell (Abraham et al., 2007; Buse, Polonsky, & Burant, 2003). Glucotoxicity also impairs insulin gene transcription and subsequent decreases in insulin synthesis (Bays et al., 2008; DeFronzo, 2004b). Support for the concept of glucotoxicity is seen when glycemic control in re-instated either by dietary changes or by weight loss. Within an normoglycemic environment, proper insulin secretion and action creates an metabolic environment where the beta cells can function as intended (DeFronzo, 2004b).

Toxic Intracellular Metabolites (Impaired Intracellular Environment)

Cytokines are bio-active molecules that activate the immune system to help fight infection. Cytokines attract cells from the immune system, such as macrophages, and neutrophils to help fight infection. Cytokines also activate the complement system, which can enhance the immune response against foreign matter (Rubin & Reisner, 2009). These bio-active molecules are designed to help fight against invaders, however they can also contribute to illness when chronically elevated. Cytokines, such as tumor necrosis factor-alpha (TNF-α), interleukin-6 (IL-6), and C-reactive protein (CRP), are frequently used to measure levels of inflammation (Olefsky & Glass, 2010), and are predictors of worsening glycemic control (E. Rhee et al., 2012). TNF-α is primarily secreted by adipose tissue and serves as a chemotactic and chemoattractant adipokine, drawing other cells to the site of injury to target the foreign cellular matter (Bays et al., 2008). TNF-α is primarily secreted by macrophages in obese adipose tissue and is specifically increased in visceral adipose tissue (Olefsky & Glass, 2010). TNF-α is involved in the evolution of cardiovascular disease, and researchers suggest that it is potentially deleterious to health (Benito, 2011). TNF-α also inhibits the actions of insulin and can

contribute to insulin resistance in obese people (Becarevic, Seferovic, Ignjatovic, Singh, & Majkic-Singh, 2011).

In persons at risk for diabetes, damage to the vascular circulation is occurring, before the diagnosis of diabetes, due to the presence of inflammatory cytokines (Genc et al., 2011; Leahy, 2005). Early and repeated exposure to inflammatory cytokines in the circulation can initiate physiologic changes within the circulatory vasculature and can contribute to atherosclerosis (Kaplan et al., 2012; Madec, Corretti, Santini, Ferrannini, & Solini, 2011). Toxic intracellular metabolites can disrupt mechanisms that maintain hemostasis, such as important anti-hypertensive agents like nitric oxide (NO) (Konukoglu, Fırtına, & Serin, 2008). NO is an important vaso-dilatator that is secreted by the arterial endothelium, which results in arterial relaxation and lowered blood pressure. However, in individuals insensitive to insulin, researchers demonstrated that secretion of NO was diminished, suggesting that cardiovascular disease may be linked to insensitivity to insulin, as well as changes in endothelial function, initiated by cytokines (Kaplan et al., 2012).

Elevated levels of IL-6 and CRP are associated with atherosclerosis and the development of T2DM, even in persons without insulin resistance (Bays et al., 2008). Similar to TNF-α, IL-6 comes from adipose tissue, and serum levels are increased in obese individuals (Caballero et al., 2008; Krysiak, Gdula-Dymek, Bachowski, & Okopień, 2010). IL-6 has been observed to (a) increase basal glucose uptake, (b) alter insulin sensitivity, (c) increase the release of adhesion molecules and (d) increase the hepatic release of fibrinogen (Elshorbagy, Valdivia-Garcia, Refsum, & Butte, 2012). IL-6 decreases lipoprotein lipase activity (Inzucchi & Sherwin, 2011), resulting in monocytes taking up more lipids, and enlarging as a result. In addition, IL-6 may

initiate atheroma development, as monocytes continue to grow in size, which is associated with future arteriosclerosis development (Farah, Shurtz-Swirski, & Lapin, 2008).

CRP levels are elevated in obesity and increase the risk of cardiovascular disease (CVD) and progression to T2DM (Chen et al., 2009; Herder et al., 2009). CRP is an acute-phase reactant protein that is elevated in sepsis and is considered to be a clinical marker of inflammation (Bays et al., 2008; Sherwood, 2007). Some of its actions include: (a) an ability to bind and activate complement; (b) induce expression of cell adhesion molecules; (c) mediate low-density lipoprotein (LDL) uptake by macrophages; (d) and induce monocyte recruitment in the arterial wall (Sherwood, 2007). The association between CRP and cardiac disease was discovered after observations of a dramatic rise in CRP levels following a myocardial infarction (MI) (Berg & Scherer, 2005). CRP also is associated with CVD risk factors such as insulin resistance, MetS, hypertension and dyslipidemia (Chen et al., 2009; Masters et al., 2010).

Oxidative Stress

Oxidative stress is defined as the release of reactive oxygen and nitrogen species in vascular cells and is harmful to the endothelial cells (Melton, Tucker, Fisher-Wellman, Schilling, & Bloomer, 2009). Oxidative stress is also toxic to pancreatic beta cells (Abraham et al., 2007; Pegklidou, Nicolaou, & J Demopoulos, 2010). Oxidative stress disrupts endothelial cells by altering their intracellular proteins and by altering the extracellular matrix, so that cells cannot interact with other matrix components (Kaplan et al., 2012). An association has been observed between increased oxidative stress and development of T2DM, suggesting that oxidative stress can contribute to illness (Pegklidou et al., 2010). One way to improve insulin function and lower disease risk is consumption of anti-oxidants (Chu et al., 2012). Oxidation of low-density lipoproteins can quickly deplete anti-oxidants; however, researchers demonstrated that dietary

supplementation of antioxidants, such as olive oil, reduced oxidative stress (Pegklidou et al., 2010). Previous research also demonstrated that markers of oxidative stress could be improved with physical activity, suggesting that oxidative stress can be reduced with health promoting behaviors (Shanely et al., 2013).

AGE Products and ROS

AGE products are created by the reaction of glucose with glycating compounds and oxidation of FFA (Kaplan et al., 2012). Reactive Oxygen Species (ROS) and Advanced Glycation End products (AGE) can disrupt normal cellular signaling (Olefsky & Glass, 2010). AGE products damage cells by modification of intracellular proteins and binding to receptors on endothelial cells (Kaplan et al., 2012). ROS over-production occurs in the mitochondria within the cell and the presence of ROS interferes with the transmission of the cell's signal (Kaplan et al., 2012). In experiments with mice, a correlation was observed between insulin sensitivity and ROS levels, particularly in diabetic mice models (Kaplan et al., 2012) The accumulation of AGE products in blood vessels and the kidneys further adds to cellular injury in the secretion of pro-inflammatory cytokines, which also damage endothelial cells (Inzucchi & Sherwin, 2011). Increased hyperglycemia, and resultant ROS, worsen glucose toxicity and oxidative stress, further damaging the beta cells (Abraham et al., 2007).

Alterations in Insulin Signaling (Impaired Activity of Insulin Signal)

The insulin-signaling pathway is complex, and alterations in the insulin pathway can contribute to insulin resistance (Jorge et al., 2011; Sandoval et al., 2009), particularly with disruptions in post-receptor cell pathways (Olefsky & Glass, 2010). Adipokines, such as TNF-α,

IL-6 and CRP, and free fatty acids alter normal tyrosine phosphorylation of IRS-1, a key molecule in insulin signaling (Capurso & Capurso, 2012). Insulin-resistant animal models are useful in demonstrating how normal tyrosine phosphorylation is reduced with insulin resistance. Under normal physiological conditions, the IRS-1 molecule links with tyrosine, which then propagates the insulin signal until glucose receptors are activated (Gokulakrishnan, Mohanavalli, Monickaraj, Mohan, & Balasubramanyam, 2009).

In less than ideal physiologic conditions, insulin receptors undergo serine phosphorylation. Now, the receptor's ability to phosphorylate IRS-1 is attenuated and IRS-1 cannot effectively transmit the signal within the cell (Capurso & Capurso, 2012; Gokulakrishnan et al., 2009). TNF-α is known to block the insulin signal via substitution of serine phosphorylation in lieu of tyrosine (Capurso & Capurso, 2012; Ho, Davy, Hickey, & Melby, 2005; E.-J. Rhee et al., 2012; Ruotsalainen et al., 2006). When serine linkage occurs at the insulin signal, any further attempts at tyrosine linkage are interrupted, and a stop signal is given to the insulin receptor (Capurso & Capurso, 2012). This altered substitution occurs in muscle and fat cells, whereas in the liver other insulin receptors function to maintain insulin sensitivity, until the cells are resistant to insulin effects and develop T2DM (Benito, 2011).

Insulin Resistance (Impaired Activity in the Muscle/Fat/Liver)

A person who is insulin resistant has low insulin sensitivity, however an insulin sensitive person is not insulin resistant (Shaibi, Roberts, & Goran, 2008). Insulin sensitivity (S_I) is a clinical measure and is used by researchers to evaluate cellular responsiveness to insulin (Chu et al., 2012; Shaibi et al., 2008). S_I is calculated by dividing the glucose infusion rate by the average plasma insulin level during the last 60 minutes of a continual glucose infusion (Chu et al., 2012). Other methods to measure insulin sensitivity include fasting plasma insulin (measured

by serum concentration of C-peptides) and the homeostatic model assessment of insulin resistance (HOMA-IR), which is a mathematical formula using clinical data from patient laboratory values (DeFronzo, 2004b; Ho et al., 2005).

Insulin resistance develops in the liver and muscle cells as a consequence of FFA concentrations, and in particular, in individuals with a family history of T2DM as well in obese persons (Capurso & Capurso, 2012; DeFronzo, 2004a). Increases in the concentration of FFAs and the by-products of FFA metabolism affect insulin-signaling pathways directly through the activation of serine-kinases within the cells (Benito, 2011). In T2DM, elevated fasting insulin levels demonstrate that patients become progressively more resistant to the effects of insulin (Capurso & Capurso, 2012). The elevated fasting insulin levels are a response to elevated lipolysis, increased adipokine/cytokine production, and elevated fasting blood glucose levels (Abdul-Ghani & DeFronzo, 2010). In many individuals, however, glucose levels remain within the normal range, because the pancreas can increase insulin production for a limited amount of time, compensating for decreased IRS-1 function (DeFronzo, 2009).

Impaired Insulin Secretion (Impaired Activity in the Beta Cells)

Researchers continue to debate whether diabetes results from insulin resistance or defects in insulin secretion (Abdul-Ghani & DeFronzo, 2010). Current literature focuses on three essential defects: defects in insulin resistance, in both skeletal muscle and liver, and defects in insulin secretion from the beta cells of the pancreas (Sherwin & Jastreboff, 2012). After food ingestion, there are two phases of insulin release: a brief, first phase, followed quickly by a second, longer phase (DeFronzo, 2004b). The first phase occurs after an acute rise in blood glucose levels and is witnessed by storage granules within beta cells releasing stored insulin into the circulation. The second phase is slower, and lasts as long as blood glucose remains elevated,

as demonstrated by an up-regulation in pre-proinsulin genes (DeFronzo, 2004b). Researchers posit that beta cell dysfunction precedes insulin resistance, because in people with diabetes, the first phase insulin response is lost, and blood glucose levels are maintained by the slower secondary phase (Kanat, DeFronzo, & Abdul-Ghani, 2015).

Insulin secretion is able to keep up with gradual increases in fasting blood glucose levels, similar to the Frank-Starling Law of the Heart (DeFronzo, 2004a). The Frank-Starling Law of the Heart posits that increased venous return to the heart results in increased cardiac output (Sherwood, 2007). The pancreas can increase secretion of insulin with elevations of fasting insulin levels two to two-and-a-half times greater in those with T2DM, compared to normal glucose-tolerant individuals (DeFronzo, 2004b). The increase in insulin secretion can offset the progressive increase in glucose concentrations and maintain homeostasis to a point (Laplante & Sabatini, 2012). When the fasting glucose level exceeds 140 mg/dL, fasting insulin levels drop rapidly (DeFronzo, 2004b).

Eventually, the beta cell loses the ability to keep up with the demand for insulin (Laplante & Sabatini, 2012). Cell death, known as apoptosis, results in the loss of functioning beta cells due to either glucose or lipid toxicity (Laplante & Sabatini, 2012) or insulin toxicity itself (Benito, 2011). Researchers suggest that between 60-70 percent of beta cell function has been lost by the time impaired glucose tolerance is observed clinically (DeFronzo, 2004b). Increased apoptosis of beta cells is challenging to measure (typically performed at autopsy) and so is of limited use to patients (Leahy, 2005). Possible suggestions for the increase in apoptosis of beta cells could be due to the presence of amylin near the cell or endoplasmic reticulum stress (DeFronzo, 2004a, 2004b; Leahy, 2005). Amylin may inhibit insulin secretion, as increased deposits of amylin near the beta cells previously resulted in beta cell dysfunction (DeFronzo,

2004b). Another possible mechanism of impaired beta cell function is endoplasmic reticulum stress, where the endoplasmic reticulum is simply overwhelmed by the presence of unfolded proteins (Leahy, 2005; Sandoval et al., 2009; Tanti & Jager, 2009).

HPA Axis

The central nervous system has a significant effect on glucose homeostasis as initially proposed by Claude Bernard in the 19th century (Sandoval et al., 2009). The hypothalamic-pituitary axis (HPA) has been an area of research interest in the development of T2DM due to the far-reaching effects of neuronal hormones on the body's metabolic, digestive, and nervous systems. Researchers continue to link perturbations of the HPA to deficiencies in growth hormone/insulin growth factor-1, insulin signaling and to illness (Chrousos, 2000; Prabhakar, Gupta, Kanade, & Radhakrishnan, 2015; Silveira et al., 2014). Researchers also posit that abnormal cortisol secretion may be an independent risk factor for beta cell dysfunction and obesity (Adam et al., 2010).

Social stressors such as divorce, living alone, unemployment, and low education can result in a negative adaption to stress and activate the HPA (Dettenborn, Tietze, Bruckner, & Kirschbaum, 2010; Engum, 2007). Once a stressor is perceived, the HPA responds acutely to the stressor, or in the case of chronic stress, remains chronically activated. A chronically activated HPA does not display the variations in a normal HPA response, such as normal peak elevations in cortisol secretion when first awakening (Chrousos, 2000; Gallagher-Thompson et al., 2006; Wahbeh & Oken, 2013). In previous research with depressed individuals, a flat cortisol response to excitement was seen, and less variability in cortisol level was witnessed throughout the day (Ahrens et al., 2008; Mangold, Marino, & Javors, 2011). Altered cortisol secretion for extended

periods of time can lead to physiologic changes in insulin secretion and reduced glucose uptake by the muscle cells (Adam et al., 2010).

Irregular Cortisol Pattern

Cortisol normally follows two patterns of secretion: a diurnal rhythm, which peaks shortly after awakening and gradually decreasing serum levels throughout the day, and a cortisol awakening response that occurs about one hour after awakening (Wahbeh & Oken, 2013). The secretion of cortisol increases energy rapidly by making glucose more available for use, and by decreasing glucose uptake by tissues other than the brain (Sherwood, 2007). Cortisol secretion is a normal response to physical, physiological, and psychological stress (Sherwood, 2007). When an individual perceives stress, an area within hypothalamus, the paraventricular nucleus, releases Corticotropic Releasing Hormone (CRH), which stimulates the release of adrenocorticotropin hormone (ACTH) (Cortés, Langlois, & Fernandino, 2014). ACTH subsequently stimulates the adrenal glands to secrete cortisol (Kalra, Einarson, Karaskov, Van Uum, & Koren, 2007). Cortisol secretion is under the influence of the HPA axis and cortisol has far-reaching effects throughout the body (Gallagher-Thompson et al., 2006). The secretion of cortisol is controlled by a negative feedback loop, and secretion diminishes when the perceived threat is removed.

Cortisol concentrations can be affected by certain medications (Roche, King, Cohoon, & Lovallo, 2013), medical conditions, such as pregnancy, and physical activity (Hill et al., 2008; Kalra et al., 2007). Hill et al. (2008) demonstrated that intense exercise can temporarily elevate cortisol levels, and that the increase in cortisol secretion depended on exercise intensity, not on duration. In individuals who engaged in vigorous exercise, cortisol levels actually increased; however, individuals who engaged in moderate exercise observed a decrease in cortisol levels

(Hill et al., 2008). The peak in cortisol secretion post-exercise is not clear. In research with aerobically trained athletes, peak cortisol level was seen in 15 minutes upon termination of exercise (Fryer et al., 2014). However, previous research with competitive athletes demonstrated similar results, except, that elevated cortisol levels were observed at 30 minutes and 120 minutes post-exercise (Bayazit, Demir, & Tosun, 2009). The difference in duration of cortisol secretion may be due to differences in the overall amount of time spent engaging in rigorous, competitive exercise when compared to aerobically trained, non-competitive exercise.

Among women, obesity may contribute to elevated cortisol levels, as researchers noted greater morning cortisol levels in abdominally obese women when compared men with similar BMIs (Larsson, Gullberg, Råstam, & Lindblad, 2009). Also, there was a significant difference in cortisol secretion by age, as cortisol level was found to be higher in older participants when compared to younger participants (Larsson et al., 2009). Gender differences in morning cortisol secretion might also be explained by the specific task an individual is undertaking. While studying teachers, researchers observed that during the early part of the day, cortisol levels were higher in women when compared to men, yet cortisol levels were higher in men during mid-day (Steptoe, Cropley, Griffith, & Kirschbaum, 2000). Study authors suggested that differences in morning secretion between the genders may reflect anticipation of early morning familial obligations; however, they found no relationship between female teachers with children when compared to those without (Steptoe et al., 2000).

There are conflicting opinions about whether stress or obesity and environmental factors result in hyperactivity of the HPA axis (Jordan & Tsai, 2010; Knapke, Nagarajan, Correll, Kent, & Burns, 2012). Exposure to chronic stress can lead to alterations in cortisol secretion, as well as diminished bodily responses to cortisol (Mangold, Wand, Javors, & Mintz, 2010; Selye, 1956;

Weigensberg et al., 2009). In individuals exposed to chronically elevated levels of cortisol, interference with insulin secretion and insulin-mediated glucose uptake in skeletal muscle occurred (Adam et al., 2010; Burke, Fernald, Gertler, & Adler, 2005; Munzberg & Myers, 2005; Wahbeh & Oken, 2013). One illness which results from an altered cortisol secretion is Cushing Syndrome. Cushing Syndrome is an illness of hyper-secretion of glucocorticoids (Sherwood, 2007). Consequences of Cushing's Syndrome include central obesity, hypertension, depression, and glucose intolerance (Bope, Kellerman, & Rakel, 2010). Central obesity and glucose intolerance result from increases in visceral adipocyte hypertrophy due to increases in glucocorticoid receptors (GC) (Bays et al., 2008). The enlarged adipose cells generate inflammatory responses, further worsening glucose resistance in the muscle cells, and increase the risk of cardiovascular disease and hypertension (Bays et al., 2008).

Hypertension

Hypertension, also known as primary hypertension, is defined as a resting blood pressure of 140/90 mmHg or greater and represents 90 percent of the cases of hypertension (Sherwood, 2007). Hypertension arises from physiologic abnormalities within the arteries, genetic predisposition, or health behaviors. Arteries have a thick layer of smooth muscle that contains sympathetic nerve fibers, which are responsible for maintaining vascular tone and continually release norepinephrine to sustain blood pressure (Sherwood, 2007). Arteries can be influenced by neural or hormonal stimuli and extrinsic molecules, which can profoundly affect the sympathetic nervous system, and subsequently alter blood pressure (Al-Daghri et al., 2007; Rosmond et al., 2003; Shankar & Xiao, 2010).

Arteries have a thin lining of endothelial cells which secrete vasodilators and vasoconstrictors that maintain vascular tone (Rubin & Reisner, 2009). Endothelial cells are

sensitive to the environment, such as hyperglycemia, which changes the endothelial cell's ability to function (Calle, 2011; Kaplan et al., 2012; Madec et al., 2011; Pegklidou et al., 2010). Under normal circumstances, endothelial cells secrete nitric oxide (NO), which lowers blood pressure through relaxation of the muscles lining the arteries (Pegklidou et al., 2010; Sherwood, 2007; Wajcberg et al., 2006). Conversely, increased concentration of insulin in the circulation attenuates the secretion of NO by the endothelial cells, raising blood pressure (Bays et al., 2008).

It is micro-vascular damage, and subsequent formation of fatty deposits in the artery, which is significantly associated with cardiovascular disease and T2DM (Abdul-Ghani & DeFronzo, 2010; Madec et al., 2011). Arterial lesions also known as, atheromas, initiate the arteriosclerotic changes of cardiovascular disease (CAD). Platelet-associated molecules, such as P-selectin and CD40L, are also associated with cardiovascular events and are elevated in people with diabetes, and in persons at risk for diabetes (Gokulakrishnan, Deepa, Mohan, & Gross, 2006; Madec et al., 2011). Researchers in India demonstrated that the prevalence of coronary artery disease was 2 to 3 times higher in diabetics and was almost 1.5 times higher in people with IGT when compared to persons with normal glucose tolerance (Gokulakrishnan et al., 2006). Researchers also reported that people with MetS had higher levels of platelet-associated molecules than those without MetS, suggesting that people with MetS have a higher risk for CAD (Gokulakrishnan et al., 2006).

Non-Modifiable Risk Factors for T2DM

Age.

Diabetes risk increases as a person ages (Davidson & Schriger, 2010; Harati, Hadaegh, Saadat, & Azizi, 2009; Sutherland et al., 2012), but that can vary depending on what part of the world one lives. Large prospective studies in the U.S. and in Europe have demonstrated a link

between age and the development of T2DM (DeFronzo, 2009). Although T2DM has become a health issue throughout the world (Wild et al., 2004), prevalence rates are not equal across developed and developing countries. In developing countries, the majority of people with diabetes are 45-64 years old, compared to the majority age of diabetics in developed countries which is older than 65 (Kommoju & Reddy, 2011). Among Latino populations, the effect of age is greater when compared to non-Latino white populations. In the U.S., the proportion of Mexican-Americans with diagnosed diabetes increases from 1.3 percent among adults younger than 39 years to approximately 25 percent among adults 60-74 years old (Caballero, 2007). In Wisconsin, the total estimated percent of adults 45-64 with diabetes is 13.9, however when compared to Latinos aged 45-64, the percentage was closer to 25 (Wisconsin Diabetes Prevention and Control Program, 2011).

Gender.

In the U.S., approximately 13.2 percent of men and 10.3 percent of women have diagnosed and undiagnosed T2DM, with men demonstrating a higher prevalence of T2DM across all age groups (Center for Disease Control and Prevention, 2014; Cowie et al., 2006). Among Latinos, the prevalence of impaired fasting glucose peaked earlier when compared to the total population of all men studied, suggesting that Latino males may be at greater risk for diabetic complications due to early development of the disease (Cowie et al., 2006). Important differences in T2DM exist between the genders, particularly in women who developed gestational diabetes. Women who develop gestational diabetes are at increased risk of T2DM after pregnancy, and their offspring have an increased risk of T2DM later (Kommoju & Reddy, 2011). Among Latino women, the prevalence of gestational diabetes is higher when compared to non-Hispanic white women (Silveira et al., 2014). Researchers observed that approximately 12

percent of Latino women with gestational diabetes progress to T2DM per year, further contributing to increased T2DM risk in Latino women (Caballero, 2007).

Ethnicity.

In an analysis of the Hispanic Health and Nutrition Examination Survey (HHANES), Mexican Americans have the highest rate of diabetes among Latino population sub-groups and are 1.7 times more likely to have diabetes compared to non-Hispanic Whites (NHW) (Aponte, 2008). Latinos have demonstrated an increased risk of developing T2DM when compared to NHWs, however the causative agent is not clear. Some suggested mechanisms include higher prevalence of gestational diabetes, the tendency to develop abdominal obesity, and higher prevalence of impaired glucose tolerance (Caballero, 2007; Díaz-Apodaca et al., 2010). Variations in obesity across ethnicities have led to designating values for obesity as determined by ethnicity (Oza-Frank, Ali, Vaccarino, & Narayan, 2009).

An important difference observed in ethnic groups compared to those of European ancestry is the rapid progression from normal to impaired glucose tolerance (DeFronzo, 2004b), as evidenced by increasing prevalence of diabetes in Asian Indians, Polynesians and Latin Americans (Boyko et al., 2010; Caballero, 2007; Chandalia et al., 2007). Similar to persons of European ancestry, Asian Indians have increased adipocyte size, increased visceral adipose tissue, increased pro-inflammatory factors, and increased insulin resistance, which can increase cardiovascular disease risk (Boyko et al., 2010; DeFronzo, 2009). Also, Asian Indians were found to have larger abdominal adipocytes when compared to Caucasians and tended to accumulate more truncal fat (Bays et al., 2008).

Previous research demonstrated that obesity contributes to insulin resistance; however, researchers observed inconsistencies when comparing Asian Americans to other ethnicities

(Abdul-Ghani & DeFronzo, 2010). The prevalence of obesity among Asian Americans is lower when compared to the U.S. average, with Asian men having one-fifth the rate of obesity when compared to American men (Wang & Beydoun, 2007). However, despite a lower waist hip ratio (WHR), Asians were more insulin resistant when compared to Caucasians, suggesting that South Asians may have a hidden obesity that increases T2DM risk (Chandalia et al., 2007). WHR, a common way to measure obesity, is associated with increased fasting levels of insulin (Borodulin et al., 2006; Chandalia et al., 2007). South Asians demonstrated greater variation in their adiposity, which might explain the increased T2DM risk in some ethnic groups. Some researchers suggest that, though Asian adipose tissue size is reduced and undergoes a lesser amount of adipogenesis, it is no less pathogenic (Bays et al., 2008; DeFronzo, 2004a; DeFronzo, 2009). Due to variations in obesity prevalence, guidelines now suggest that the upper limits of normal-weight persons' BMI among Asians be lowered from 18.5-24.9 kg/m^2 to 18.5-22.9 kg/m^2 (Oza-Frank et al., 2009).

Genetics.

Attempts by the scientific community to locate a causal genetic link between T2DM and an individual gene have not yet been productive, suggesting that T2DM results from poly-genetic defects (Bastarrachea et al., 2007; Gerich, 2003; Kommoju & Reddy, 2011; Leahy, 2005). Early research with calpain-10 in Mexicans suggested a possible causal, genetic link between calpain-10 and diabetes development among Mexicans, but later research demonstrated that calpain-10 played essentially no role in impaired glucose regulation (Malecki, 2005). Researchers also suggested a link in the gene coding between IRS-1 and metabolic syndrome as a possible precursor to T2DM, however, this also was inconclusive (Groop, 2000; Kommoju & Reddy, 2011; Leahy, 2005). Some other possible protein expression defects that may be influential in

T2DM development include; (a) leptin; (b) β_2-adrenergic receptors; (c) lipases; (d) glucokinase mutations; (e) hepatocyte nuclear factor-α (HNF-1α); (f) peroxisome proliferators-activated receptors PPARγ; (g) glycoprotein PC-1; (h) and even point mutations in mitochondrial function (American Diabetes Association, 2013). Researchers continue to examine possible defects in protein expression as contributors to T2DM development.

The polygenic link involved in T2DM development may be an interaction among the environment, genetic background and contributions of many other genes (Malecki, 2005; Norris & Rich, 2012). Research with polygenic T2DM development suggests that up to 40 genetic variants may be associated with T2DM development (Cho et al., 2012). Researchers posit that current candidate genes associated with T2DM exert their effect through the beta cells of the pancreas, not via insulin resistance pathways (Norris & Rich, 2012). At the genetic level, current research would indicate that beta cell dysfunction is the first factor in the development of diabetes; however, examination of candidate genes within the beta cell have demonstrated inconsistent results (Kommoju & Reddy, 2011; Norris & Rich, 2012).

The current assumption is that genetic defects in T2DM development occur in post-receptor conduction processes, and not in defects with IRS-1 receptor gene expression (American Diabetes Association, 2013). Despite the advances in sequencing the genome, there continue to be challenges in studying the large number of potential genes, as well as the interaction between a specific gene and the environment. Due to the complexity of T2DM as an illness, separating genetic influences from environmental influences is difficult. Researchers speculate that genetic factors may become activated by environmental influences, such as changing food patterns and urbanization or may act in combination (Kommoju & Reddy, 2011)

Although monogenic forms of diabetes have been identified, these are relatively rare. One rare form of diabetes that has demonstrated a strong genetic link is Maturity Onset of Diabetes in the Young (MODY). Unlike T2DM, MODY is a monogenic form of diabetes mellitus, resulting from an impaired glucose-stimulated insulin secretion rate. MODY is an autosomal dominant subtype of T2DM, characterized by early age of onset, mild-to-moderate fasting hyperglycemia, and impaired insulin secretion (DeFronzo, 2004b). Patients with MODY demonstrate symptoms that are similar to persons with T2DM. Some of the possible genes identified as contributing to the onset of MODY include glucokinase, and four transcription factors: Hepatic nuclear factor genes (HNF-1α), (HNF-4α), insulin promoter factor 1 and (HNF-1β) (DeFronzo, 2004b). All of these transcription factors are involved in the regulation of genes in glucose metabolism and insulin secretion. For example, in people who carry mutations in HNF-4α, a progressive loss of β-cell function and increased hyperglycemia is observed (DeFronzo, 2004b).

Genetic variability among ethnic populations has been suggested as an explanation for alterations in reduced glucose tolerance and insulin insensitivity, which may explain why some ethnic groups are more susceptible to developing diabetes (Cai, Cole, Butte, Voruganti, & Comuzzie, 2007; Celi et al., 2000; Kovacs et al., 2003). For example, IRS-1 gene variants, Ala512Pro, Gyy972Arg, Pro170Arg, Ser809 Phe, have been identified as resulting in decreased insulin sensitivity (Celi et al., 2000). Variations in expression of specific genetic variants also have been observed. For example, among Mexican Americans, the IRS-1 variant Gly971Arg is more common, yet was not observed while studying the Pima Indian populations (Celi et al., 2000).

Ethnic minority populations appear to have an increased prevalence of obesity and the reasons may be a combination of genetic susceptibility, lifestyle behavior, and unfavorable environment (Schulz et al., 2006). The Pima Indians are genetically predisposed to insulin resistance (IR), obesity, and the development of T2DM (Bays et al., 2008). Pima Indians have one of the highest prevalence rates of T2DM and researchers suggest that the rate of obesity coupled with larger adipocytes puts Pima Indians at the greatest risk for T2DM development (Bays et al., 2008). The study by Schulz et al. (2006) examined the effect of environment on two groups of Pima Indians, one group living in the U.S. and the other in Mexico. The two Indian groups were genetically similar and lived in remote areas. Non-Pima Mexican participants served as a comparison group. The prevalence of T2DM between the Mexican and the U.S. Pima Indians was significantly different: 5.6 percent of men and 8.5 percent of women in Mexico had T2DM compared to 34.2 percent of men and 40.8 percent of women in the U.S. The prevalence of IGT also was more prevalent among the U.S. Pima Indians when compared to the Mexican groups (Schulz et al., 2006). There were also significant differences in physical activity and obesity prevalence between the groups. The researchers posited that, while physical inactivity and diet are significant risk factors for T2DM, the higher rate of obesity among the U.S. Pima Indians explained the difference in T2DM prevalence (Schulz et al., 2006).

Family history.

A significant link between T2DM and family history came from studies among identical twins, particularly when one of the twins developed T2DM. Researchers observed nearly 100 percent concordance in T2DM development in the other twin when the first identical twin developed the disease (Olefsky & Glass, 2010). Previous investigators who examined the offspring of diabetic parents demonstrated an increased risk of diabetes development, and

suggested that T2DM development was associated with family history (DeFronzo, 2009; Yang, Liu, Valdez, Moonesinghe, & Khoury, 2010). Later research with NHANES data supported earlier findings and researchers demonstrated that family history of diabetes was an independent risk factor of undiagnosed diabetes (Yang et al., 2010). People with a family history of T2DM also demonstrate warning signs of T2DM, such as insulin resistance, beta cell dysfunction and weight gain before diagnosis (Kelly et al., 2007).

Previous research demonstrated that insulin resistance was frequently clustered in families (Leahy, 2005; Whitford, McGee, & O'Sullivan, 2009). The risk of T2DM in offspring is 40 percent if one parent has the disease; however, the risk increases to 70 percent if both parents are diabetic (Kommoju & Reddy, 2011). If the mother is diabetic, there is also an increased risk of illness in the offspring, compared to just the father having the illness (Kelly et al., 2007; Kommoju & Reddy, 2011). How offspring progress to become glucose intolerant is not clear. Differences in inflammatory cytokine activity were observed in offspring of diabetics (Ruotsalainen et al., 2006), suggesting that low-grade inflammation may precede the onset of T2DM in some individuals. Another theory posits that visceral fat precedes insulin resistance in genetically predisposed individuals, and that the visceral fat later contributed to insulin resistance (Inzucchi & Sherwin, 2011; Ruotsalainen et al., 2006).

Diagnostic Test for Diabetes

Commonly used methods to test whether an individual has diabetes are fasting plasma glucose and/or impaired glucose tolerance using the Oral Glucose Tolerance Test (OGTT) (American Diabetes Association, 2013; Costa et al., 2011). Diagnosis of diabetes is made when an individual has a plasma glucose level of $\geq$ 200 mg/dl during an OGTT or a fasting plasma glucose of $\geq$ 126 mg/dl. An important measure for measuring long-term blood sugar control is

Hemoglobin A1c. $HbA1_c$ is a measure of 2-3 months' average of blood glucose concentrations (Costa et al., 2011). $HbA1_c$ levels have become a widely used measure to identify people with diabetes. Both the International Expert Committee and the American Diabetic Association agree that a threshold of $HbA1_c$ of ≥6.5 percent serves as diagnostic of diabetes (American Diabetes Association, 2013).

Diagnosis of Pre-Diabetes

The World Health Organization (WHO) and the American Diabetes Association (ADA) both define normoglycemia as <100 mg/dL or <5.6 mmol/l, and diagnostic hyperglycemia as ≥ 126 mg/dL or ≥ 7.0 mmol/L (Bonaldi et al., 2011). The diagnosis of pre-diabetes among populations can vary depending on the criteria used. In an examination of the two regulating organizations, there were slight differences in the diagnosis of impaired fasting glucose. The WHO defines impaired fasting glucose as ≥ 5.6 mmol/L (110 mg/dL) and <7.0 mmol/L (126 mg/dL); however, the ADA defines impaired fasting glucose as ≥ 100 mg/dL and < 126 mg/dL (American Diabetes Association, 2013; Bonaldi et al., 2011). The criterion chosen can result in large differences in pre-diabetes prevalence among populations, as witnessed in a population study conducted in France. In the French National Health and Nutrition study, researchers compared 18-74-year-old adults using the ADA/WHO criteria, and discerned the rate of undiagnosed diabetes to be low, around one percent. When using the ADA criteria, 15.5 percent of adults would be diagnosed as pre-diabetic. Conversely, when using the WHO criteria, only 5.6 percent would be diagnosed as pre-diabetic (Bonaldi et al., 2011).

Fasting glucose/OGTT.

The OGTT is used to measure insulin response to glucose, is an indirect measure of beta cell function and continues to serve as a diagnostic test for T2DM. The OGTT is one way to

detect an impaired response to a glucose load, since $HbA1_c$ and fasting plasma glucose cannot accurately detect IGT (Benjamin, Valdez, Geiss, Rolka, & Narayan, 2003; Cowie et al., 2010; Cowie et al., 2009). However, the OGTT is time-consuming and expensive to administer, whereas a fasting blood glucose is a simple, rapid test, which can be used as a screening tool (Zhou et al., 2010). However, the OGTT measures beta cell function, which may be useful in at risk persons, as even in normal glucose-tolerant individuals at the upper limits of glucose tolerance, it is estimated a 50% loss of beta-cell function may have occurred (DeFronzo, 2004b; DeFronzo, 2009). The American Diabetic Association has therefore recommended lowering the value for impaired glucose tolerance between 140-199 mg/dl in an OGTT or an $HbA1_c$ of ≥ 5.7 to < 6.5 to better predict diabetes (American Diabetes Association, 2013).

HbA1C

Hemoglobin A1C ($HbA1_c$) is a serum biomarker that measures the average control of glucose metabolism in diabetic patients over a period of two to three months (Bennett, Guo, & Dharmage, 2007). Despite its cost, the $HbA1_c$ has advantages for clinicians, because it is more convenient (greater stability), fasting is not required, and the test results do not vary during times of stress (American Diabetes Association, 2013; Cowie et al., 2010). $HbA1_c$ is not always completely accurate, however, providing erroneous results in cases of trauma, anemia, and iron deficiency (American Diabetes Association, 2013).

The data regarding the use of $HbA1_c$ alone as a screening tool are mixed. $HbA1_c$ values are useful to diagnose diabetes; however, $HbA1_c$ did not always distinguish people with pre-diabetes (individuals with IGT or IFG) from normal glucose tolerate people (Bennett et al., 2007; Costa et al., 2011). Researchers demonstrated that the fasting plasma glucose test performed better in identifying pre-diabetes among the Chinese population when compared to using a

$HbA1_c$ (Zhou et al., 2010). Moreover, a study of Spaniards with diabetes and pre-diabetes, the researchers discovered that $HbA1_c$ alone was not effective at identifying individuals at risk for T2DM compared to utilizing $HbA1_c$ and fasting plasma glucose (Costa et al., 2011).

The recent move towards using the $HbA1_c$ as a diagnostic tool for T2DM was in response to a recommendation from the American Diabetic Association (ADA) (American Diabetes Association, 2013). Historically, the use of $HbA1_c$ was a tool used by clinicians to determine how well individuals with T2DM managed their blood sugars. In 2010, the ADA adopted the use of $HbA1_c$ as a new diagnostic criterion for people with prediabetes, because the test easily identifies abnormal glucose levels (Sentell, He, Gregg, & Schillinger, 2012). The adoption of additional tests to identify at-risk individuals may help to quantify the total number of people with pre-diabetes, but also may lead to disparities in disease estimates. Using NHANES data, researchers demonstrated that the previous measures of prediabetes (IGT and/or IFG) classified more non-Hispanic whites and Hispanics as being pre-diabetic. However, when using the new $HbA1_c$ criterion, researchers illustrated that more non-Hispanic blacks were identified as having pre-diabetes (Sentell et al., 2012). Depending on the criterion used, non-Hispanic blacks may not be identified as at-risk for diabetes, and early opportunities to intervene will be missed, possibly contributing to further disparities in health care outcomes.

Any diagnostic test has a trade-off between sensitivity and specificity. In the French DESIR study, researchers demonstrated the optimal $HbA1_c$ value was 5.7 percent and had a sensitivity and specificity of 66 and 88 percent, respectively for detecting T2DM (Droumaguet et al., 2006). Among a population of older, overweight American male veterans, researchers reported that patients with an elevated $HbA1_c$ (defined as 6.1% to 6.9%) had a 3.6 percent annual incidence rate of diabetes (Edelman, Olsen, Dudley, Harris, & Oddone, 2004). In a separate

analysis of the DISER study, the study authors reported that FPG levels of 108mg/dL and $HbA1_c$ levels of 6 percent were indicative of diabetes risk (Massin et al., 2011).

Future pre-diabetic risk estimates might be calculated using both traditional (IFG/IGT) and newer ($HbA1_c$) testing. Current recommendations to identify high-risk individuals recommended by the ADA are: $HbA1_c \geq 6.5\%$; a fasting plasma glucose $\geq$ 126 mg/dl; or a two-hour plasma glucose $\geq$ 200 mg/dl (American Diabetes Association, 2013). Among individuals with pre-diabetes, the $HbA1_c$ criterion alone diagnosed only 34.2 percent of participants, with pre-diabetes, while the remaining 65.8 percent were diagnosed with both $HbA1_c$ and fasting blood glucose (Costa et al., 2011). Analysis of NHANES data demonstrated that a $HbA1_c$ cutoff of >6.5 identified one-third fewer cases when compared to fasting blood glucose (American Diabetes Association, 2013). In another study using NHANES data, researchers reported that using $HbA1_c$ criteria alone would detect about one-tenth of the prevalence of IFG or IGT (Cowie et al., 2010).

Psychosocial Influences

Diet

Dietary recommendations from the American Heart Association (AHA) reflect the impact that lifestyle behaviors have on health promotion. Recommendations, such as (a) balanced caloric intake; (b) consuming a diet high in vegetables and fruits; (c) whole grain, high-fiber foods; (d) a serving of oily fish at least twice weekly; and (e) limited intake of saturated and trans fats are associated with improved health outcomes (American Heart Association Nutrition Committee, 2006). Researchers also reported that reductions in carbohydrate intake were also associated with weight loss and improvements in insulin resistance (Ata et al., 2010).

Western dietary patterns of red and processed meats, desserts, French fries, and refined grains is positively associated with elevations in plasma CRP, sICAM-1, sVCAM-1and E-selectin (Nettleton et al., 2006). Conversely, the less-processed diets of fruits and vegetables were inversely associated with plasma CRP and E-selectin (Esposito et al., 2004; Nettleton et al., 2006). The association of refined grains and subsequent increase in inflammatory markers also was observed in the Multi-Ethnic Study of Atherosclerosis and the Nurses Health Study (Calle, 2011). Diets that were low in fat and high in fruits and vegetables were also associated with lower risk of cardiovascular disease and T2DM (Barrera Jr et al., 2012; Ghaddar et al., 2010; Nettleton et al., 2006; Pegklidou et al., 2010). In a secondary analysis of the Insulin Resistance Atherosclerosis Study (IRAS), researchers noted a correlation between lower inflammatory response (decreased AGE production) and consumption of whole grains, however, the relationship was likely mediated by the presence of obesity (Masters et al., 2010).

Carbohydrate intake.

Diets high in carbohydrates, along with consumption of large amounts of saturated fats are associated with increases in inflammatory markers (Calle, 2011; Madec et al., 2011; Nettleton et al., 2006). Researchers suggested that diets should be comprised of 12 percent or less of carbohydrate, with 31 percent protein, and 54 percent fat (Westman et al., 2007). The reduced amount of carbohydrates did not result in a post-eating increase in insulin secretion (Westman et al., 2007). Individuals with T2DM who consume low carbohydrate diets demonstrate modest weight loss, a lower inflammatory response and lower insulin response (Ata et al., 2010; Westman et al., 2007; Wood & Fernandez, 2009). How the body responds to ingested carbohydrates also can depend on how the carbohydrate was prepared. Cooked starches, such as bread, rice and potatoes, elicit a glucose response similar to ingesting sugar.

Uncooked starches are more slowly digested and bring about a lower rise in glucose concentrations (Johnson et al., 2009), but cooked whole oats elicit a lower glycemic response when compared to processed breakfast cereals (Johnson et al., 2009).

Saturated fat intake.

Diets high in saturated fats can increase levels of endothelial cell activity, even in the absence of obesity (Calle, 2011; Esposito et al., 2004; Madec et al., 2011). Madec et al. (2011) observed a relationship between increased fat intake and inflammatory cytokines by using healthy, non-smoking participants to examine if a fatty meal would result in endothelial changes. Blood samples from individuals with and without a family history of diabetes (defined as being offspring of diabetic parents) were measured at two- and six-hours post-meal (52 percent of the meal comprised fat). In individuals without a history of diabetes, there was no change in IL-6, pro-inflammatory molecules, or intra-cellular adhesion molecules (ICAM-1) or (VCAM-1). In individuals with a history of diabetes, both adhesion molecules were elevated, but the increase was not statistically significant (Madec et al., 2011).

Consumption of a Mediterranean diet was associated with improvements in endothelial function and also brought about a significant reduction in markers of systemic inflammation (Esposito et al., 2004). The Mediterranean style diet is based on dietary foods high in antioxidants, healthy fat and fiber (Esposito et al., 2004). After a two-year follow up, researchers demonstrated that participants who consumed a Mediterranean diet had a significant reduction in MetS risk (Esposito et al., 2004). While limiting the amount of saturated fat in the diet is important, polyunsaturated and monounsaturated fats, as well as dietary fiber, are essential to long-term health. However, nutritional studies are not usually carried out over long periods of time, and it is not known if long-term adherence to a particular diet will further lower diabetes

risks (Pegklidou et al., 2010). Current research examining the effects of high fat dietary exposures suggest that an association may exist between *in-utero* exposure to high fat diets with diabetes later in life, lending further support to health dietary choices (Vuguin et al., 2013).

Alcohol intake.

Some studies suggested that heavy alcohol consumption was associated with an increased risk of diabetes, yet evidence is limited (Beulens, Rimm, Hu, Hendriks, & Mukamal, 2008; Wannamethee, Shaper, Perry, & Alberti, 2002). In one study that examined people with T2DM, moderate consumption was associated with a lower risk of cardiovascular events and micro-vascular complications (Blomster et al., 2014); but the cardiovascular benefit was observed predominantly in wine drinkers (American Heart Association Nutrition Committee, 2006). In a longitudinal study of people without diabetes, researchers demonstrated that individuals who heavily consumed alcohol (defined as > 6 drinks per day) and individuals who did not drink at all had a significantly higher risk of diabetes when compared to moderate drinkers (Wannamethee et al., 2002). Moderate alcohol ingestion (defined as three to six daily drinks) was associated with a lower risk of diabetes; however, the protective effects of alcohol were reduced after adjustment for participant body mass index. Similarly, in a nested case-control study using data from a longitudinal study of women's health, researchers observed a protective effect in individuals who consumed moderate amounts of alcohol. Researchers did not observe any association between inflammatory markers and a lower risk of diabetes, suggesting that endothelial dysfunction may not be a contributing factor to diabetes risk in people who consume moderate amounts of alcohol (Beulens et al., 2008).

Latino dietary patterns.

Dietary preferences vary across Latino regions and countries and cultural differences in how foods are prepared exist, so referring to certain items as traditional Latino foods may be misleading (Caballero, 2007). As Latinos become more acculturated to American dietary preferences, they consume more processed foods in lieu of fruits and vegetables (Pérez-Escamilla, 2011; Perez-Escamilla et al., 2008). Researchers have observed that the ethnic group with the highest intake of refined grains was youngest in age and was comprised of a large percentage of Latinos (Masters et al., 2010). Calle (2011) examined food patterns among Latinos, and observed no differences between men and women in macronutrient intake. Latino men consumed more refined grains per day than women, and consequently, markers of inflammation were significantly higher in men than in women (Calle, 2011, p. 141). Both Latino men and women also reported low intake of dietary fiber. Cultural foods are important to Latinos, despite acknowledgment that their food preferences are not exactly healthy for them (Mikell et al., 2016).

Culturally tailored dietary interventions are important to change dietary patterns if increasing health-promoting behaviors is the intended outcome. However, awareness of health-promoting behaviors does not always result in improved dietary behaviors. In a study of Latinos with diabetes, participants referred to poor nutrition as a possible contributing factor to diabetes; however, participants were less concerned about how excess weight increased their risk (Rosal et al., 2011). Dietary behaviors also may depend on whether or not the person has diabetes already. Puerto Ricans with diabetes were more likely to modify their diets to reduce dietary fat intake when compared to those without diabetes, and they were more likely to avoid fried foods (Melnik, Spence, & Hosler, 2006). Puerto Ricans with T2DM were also more likely to replace high fat foods with fruits and vegetables. Targeted interventions toward Latinos at risk for

T2DM are effective at improving health promotion, particularly when delivered using a culturally sensitive approach (Ruggiero et al., 2011; Vincent, 2009; Delia S West, T Elaine Prewitt, Zoran Bursac, & Holly C Felix, 2008). Why some interventions are effective, and others not, may depend on the amount of social support Latino participants receive as they engage in health promotion.

Social support has been seen previously as effective in improving dietary behaviors (McEwen, Pasvogel, Gallegos, & Barrera, 2010; Perez-Escamilla et al., 2008; Staten, Scheu, Bronson, Peña, & Elenes, 2005; Vincent, 2009). Social support is an important influence among Latinos and aids in the adoption of healthy dietary practices (Martyn-Nemeth et al., 2010; Vincent, 2009). In a study of Latino females with more than one chronic condition, participants reported better dietary behavior when social support also was present (Bull, Eakin, Reeves, & Kimberly, 2006; Teufel-Shone, Drummond, & Rawiel, 2005). In a systematic review of Latino studies on T2DM behavioral outcomes and nutritional knowledge, researchers demonstrated that promotoras (a form of social support) improved diabetes knowledge, improved $HbA1_c$ levels, and enhanced diabetes self-management (Perez-Escamilla et al., 2008).

Weight Loss

Benefits for adults.

Sustained intentional weight loss is associated with reduced mortality and may delay progression to T2DM (Norris et al., 2009; Ventura et al., 2009; Delia S. West, T. Elaine Prewitt, Zoran Bursac, & Holly C. Felix, 2008). In a systematic review by Norris et al. (2009), researchers examined the effectiveness of diet, physical activity, and behavioral weight loss interventions. The review consisted of studies in which participants had pre-diabetes (defined as impaired glucose tolerance), and only included interventions with weight loss as the primary

goal. The authors reported that diabetes prevention programs resulted in a significant weight loss of up to 2 to 3 kg at year one and at year-two follow-up (Norris et al., 2009). A significant association also was observed between the number of contacts with the participants and weight loss. Studies with a longer follow-up period (up to 10 years in one study), which included sustained, intensive and multicomponent interventions were efficacious in preventing T2DM (Norris et al., 2009).

Benefits for adolescents.

The rising prevalence of T2DM in children and adolescents is another reason why communities need to consider environmental factors and possibly sedentary behaviors, as ways to reduce future diabetes risk (Pegklidou et al., 2010). Weight loss from adolescence into adulthood also has been shown to reduce risk factors for developing T2DM. Using data from a prospective cohort study, researchers reported that youth with metabolic syndrome had 12 times the risk of developing T2DM in adulthood (Magnussen et al., 2012). In the study by Magnussen et al. (2012), researchers also demonstrated that the youth who did not become diabetic in adulthood had adopted healthier behaviors, such as eating more fruit and weight loss. Healthier food choices are one way to counteract the rising prevalence of obesity in youth. In the study by Ventura et al. (2009), the authors noted that Latino adolescents who decreased their added sugar intake by 47 g/d, equal to one can of soda, decreased their insulin secretion by an average of 33 percent. Researchers also observed participants who increased their fiber intake by 5 g/d, equal to one half cup of beans, had a reduction in visceral adipose tissue by an average of 10 percent (Ventura et al., 2009). Public health programs, such as healthy nutritional choices in school lunch programs, may be a way to lower obesity prevalence, particularly in young at-risk populations.

Physical Activity

Early research demonstrated that modest weight loss, changes in dietary patterns and increased physical activity are effective in preventing T2DM (Goldman & Ausiello, 2004; Knowler et al., 2002; Knowler et al., 1995). Consequently, health care providers recommended that many patients at risk for T2DM change their dietary behaviors and engage in moderate physical activity (Colberg et al., 2010; Hamer & Stamatakis, 2012; Holme et al., 2007; Ilanne-Parikka et al., 2010). Lack of physical activity can initiate and accelerate the metabolic alterations of diabetes; however, regular physical activity can delay the progression and may even reverse the development of T2DM (Borodulin et al., 2006; Gelaye, Revilla, Lopez, Sanchez, & Williams, 2009; Ilanne-Parikka et al., 2010).

Studies have examined the benefits of dietary modification and LTPA on both diabetes risk reduction and on lower levels of systemic inflammation (Kommoju & Reddy, 2011; Shaibi et al., 2008; Shanely et al., 2013; Ventura et al., 2009). In interventions that paired physical activity with weight loss, a decrease in inflammatory marker secretion was noted, as well as reduced levels of oxidative stress (Ata et al., 2010; Shanely et al., 2013). In the study by Hamer and Stamatakis (2012), the researchers reported a dose-response association, demonstrating the protective effect of physical activity even after adjusting for age, gender, smoking, socioeconomic group, cardiovascular medications, and metabolic risk factors. The study authors observed modest cardiovascular protective benefits with as little as 30 minutes per week of moderate to vigorous physical activity, suggesting that people can obtain health benefits by committing to exercising. With demonstrated health benefits from physical activity, what are some of the barriers that prevent people from exercising?

Sociocultural Influences

Socio-Economic Status

People live in cultural and social milieus that can shape eating behaviors and access to healthy foods (Pender et al., 2011). Individuals with lower socio-economic status (SES) are more likely to experience unhealthy environments and encounter barriers to health-promoting behaviors, such as lack of access to healthy foods (Acevedo-Garcia, Osypuk, McArdle, & Williams, 2008; Caballero, 2007). Prior researchers demonstrated that poorer physical environments were not supportive of active lifestyles, and lacked adequate lighting and safe streets to walk (Acevedo-Garcia et al., 2008; Keller et al., 2013).

Lower SES and chronic stress are negatively associated with physical health, and positively related to smoking and increased consumption of alcohol (de Castro, Voss, Ruppin, Dominguez, & Seixas, 2010), as well as increased BMI (Keller et al., 2013). Socio-economic status predicted whether an individual had healthcare coverage; and with increased income, the likelihood of healthcare coverage increased (Aldridge, Daniels, & Jukic, 2006). One study reported that socio-economic position independently predicted T2DM in adulthood, especially among women, suggesting T2DM may have environmental and behavioral influences (Maty, Lynch, Raghunathan, & Kaplan, 2008).

Stress of Acculturation

Of the approximately 47 million Latinos in the United States, it is estimated that 19 to 50 percent are undocumented immigrants (Amirehsani, 2010; Arbona et al., 2010). The stress due to separation from one's family, learning a new language and cultural system, and the constant threat of deportation may result in negative health consequences (Cordova & Cervantes, 2010). The physical effects of stress from acculturation and early exposure to traumatic events may increase Latinos' vulnerability to illness (de Castro et al., 2010; Flores et al., 2008; Mangold et

al., 2010). The stress of immigration to the United States may precede the onset of illness in some Latinos.

Somatic and social sources of stress due to acculturation have been reported by immigrants (Mangold et al., 2010). Stress from acculturation can confound the impact of perceived stress among immigrants and possibly elicit a negative adaptive response. In order to explore physiological and psychological stress, researchers measured the stress of caregiving on two ethnicities, non-Latino whites and Latinos. Researchers saw a flattened cortisol awakening response in both Hispanic and non-Hispanic white caregivers when compared to non-caregivers. What surprised the researchers was they witnessed a flattened cortisol slope among Hispanic participants, regardless of caregiver status (Gallagher-Thompson et al., 2006). Ethnicity and depressive symptoms were significant predictors of daytime cortisol slopes. The study authors posited that sociocultural factors may be contributing to Latinos flattened cortisol slopes and could increase the risk of physical illnesses and depression (Gallagher-Thompson et al., 2006).

The cultural values, beliefs and practices of Latinos can influence the perception of diseases and their treatment, however, level of acculturation may serve as a protective factor (Caballero, 2007). Acculturation status can influence health-promoting behaviors by raising and lowering risk factors for illness (Barrera Jr et al., 2012). Latino acculturation among women was associated with lower saturated fat intake (lower risk factor), however Latino acculturation also was associated with less physical activity when compared to U.S.-born Latino women (increased risk factor) (Barrera Jr et al., 2012). Similar results were observed in a study among Latinos living near Mexican border communities in the southwest U.S. Among Latinos who were less acculturated, a higher frequency of fruit and vegetable intake was observed (Ghaddar et al., 2010). Participants with higher levels of acculturation were more likely to have negative health

indicators, including limitations in activities by physical or mental problems, diabetes diagnosis, or obesity (Ghaddar et al., 2010).

Access to Healthcare Services

Urban vs. rural populations

A possible contributing factor to the dramatic rise in diabetes incidence may be due to the transition of many people moving from rural societies to urban ones (Kommoju & Reddy, 2011; LaMonte, Blair, & Church, 2005b). Reduced levels of physical activity and increased inflammatory markers were observed in urban populations, when compared to rural areas. Researchers from Saudi Arabia who performed a National Epidemiological Survey demonstrated that random plasma blood glucose concentrations were significantly higher in urban populations when compared to rural populations (Al□Nuaim, 1997). The significant difference in plasma glucose concentration was not dependent on either gender or age, as illustrated by a rural population that was not significantly older than the urban population. The urban population was both significantly taller and heavier than the rural population, which suggests that obesity may not be the only cause of impaired random glucose concentration in some populations (Al□Nuaim, 1997). The differences between rural and urban groups were significant even when controlling for the confounders of age, sex, BMI and waist-hip-ratio (WHR) (Al□Nuaim, 1997; Yudkin, Yajnik, Mohamed-Ali, & Bulmer, 1999; Yudkin, Kumari, Humphries, & Mohamed-Ali, 2000).

Urban settings have resources that may not be present in more rural locations. Rural populations are at increased risk for illness due to distance and financial limitations, which limit access to health promotion behaviors, such as visiting a primary care provider (Wenzel, Utz, Steeves, Hinton, & Jones, 2006). Researchers examined rural African American populations in

the South and reported that diabetes incidence was higher compared to the rest of the nation (Wenzel et al., 2006). Wenzel et al. (2006) posited that the increased incidence of diabetes in rural communities might be related to access to healthcare resources, as well as cultural barriers. Researchers suggest that environmental contaminants, such as pollutants, along with psychosocial factors, might contribute to increased risk of diabetes in urban residents compared to their rural counterparts (Yudkin et al., 2000).

Community health centers

History of the model.

The Community Health Center (CHC) has roots in the 1960s, during the American Civil Rights Movement, when attention to inequities in schools, public housing, and voting intensified. The concept of a community-based primary care clinic originated from Tufts Medical School as a pilot program to address unmet health needs among at-risk populations. In CHCs, patient populations are comprised of ethnic minorities, immigrants and those with limited access to healthcare services (Shi et al., 2009). The CHC model focused on out-reach, prevention and education (Lefkowitz, 2005).

The concept of community-based primary care continues to evolve as CHCs co-exist within the health care marketplace. The CHC model of care was successful in improving access to health care providers and adopted the concept of a Patient Centered Medical Home (PCMH) model. The PCMH model re-organizes CHCs to reduce disparities and to improve health care access, by coordinating health care services and increased use of electronic health record technology (Anderson & Olayiwola, 2012). A medical home builds on continuity with a primary healthcare provider and is associated with lower costs and reduced hospitalizations (Proser, 2005; Starfield & Shi, 2004). Some of the required elements to transform a CHC into a PCMH

include: (a) modifications to staff workflow to maximize efficiency; (b) access to psychosocial services; (c) population based care with a focus on patients at risk for poor outcomes; and d) providing health information and treatment goals to patients (Calman et al., 2013). Vulnerable populations who have a patient-centered medical home also report a (a) greater receipt of preventative services, (b) less missed or delayed care, (c) more effective care for chronic conditions, and (d) better overall health (Shi & Stevens, 2007). In one study that evaluated the effectiveness of the PCMH model, researchers demonstrated that the model increased patient access to a broad group of health care providers and lowered the number of overall visits (Calman et al., 2013).

Decreased barriers to health care.

Access to health care is a problem for 17 percent of the U.S. population; either because they cannot afford health care coverage or are deemed ineligible for it (Leifer & Zakhein, 2007; Shi, Stevens, & Politzer, 2007; Stevens, 1992). People of lower SES are less likely to have a primary care provider and frequently encounter barriers to specialty care (Anand et al., 2010; Cook et al., 2007; Leifer & Zakhein, 2007). Many ethnic groups feel marginalized by the health care system and do not pursue preventative services. When faced with barriers to primary care, individuals often seek medical care in emergency rooms, and many times vulnerable populations experience long waits for care (Hsia & Tabas, 2009). Among Latinos, some barriers to health care access include: (a) a lack of bilingual health care providers; (b) cultural differences; (c) lack of health care insurance; (d) and lack of health literacy (Aldridge et al., 2006; Amirehsani, 2010; Caballero, 2007). Only when barriers to health care access are removed can a regular source of health care services be established.

A regular source of health care is associated with improved quality of care (Aldridge et al., 2006; Falik et al., 2006; Proser, 2005). Health care access increases the opportunity for patients to undergo preventative health care services. CHCs have demonstrated successful prevention outcomes, including: (a) increased mammography use; (b) cessation of smoking; (c) increased childhood immunization rates; and (d) reductions in the incidence of pre-term births (Aldridge et al., 2006; U.S. Department of Health and Human Services, 2011). In fact, low-income, Hispanic women who had established relationships with health care providers were more likely to have mammograms when compared to those who sought care in acute settings (Aldridge et al., 2006).

Increased use of emergency rooms.

Research demonstrated that people with lower SES, who also had higher prevalence of chronic illness, were more likely to use emergency medical care (ER) (Shah & Cook, 2008). Some predictors of increased use of the ER were a lack of resources, such as transportation, lower household income and living in rural areas (Falik et al., 2006; Rust et al., 2009). Health care access provided by CHCs helps to avoid inappropriate ER visits and helps to reduce admissions to the hospital by targeting ambulatory care sensitive conditions (ACSC). ACSC include specific conditions, such as asthma, diabetes, and acute conditions in which appropriate primary care would reduce the likelihood of admission (Weir et al., 2010). ACSC are referred to as avoidable admissions, and ambulatory care sensitive hospitalizations are used as a measure of health care access (Falik et al., 2006). In the study by Falik et al. (2006), Medicaid beneficiaries relied on CHCs for primary care and a significant difference was observed in hospital ER visits and ACSC admissions compared to other Medicaid providers and people with no provider. In another analysis of ER utilization in Georgia, researchers also observed a statistically significant

increase in ER use in counties where no CHC was available. Non-CHC counties had a 33 percent greater rate of ER visits, and a 37 percent greater risk of ACSC visits (Rust et al., 2009).

Focus on preventative care.

The presence of a CHC in at-risk communities serves as an entry point for vulnerable community members to obtain health care services and obtain aid with chronic disease management. Independent of insurance status, CHC patients were more likely to have had a visit in the past year, to have a regular source of care, to have received a mammogram in the past two years, and to have received counseling on physical activity (Kirby & Kaneda, 2005; Shi & Stevens, 2007). CHCs have made a significant impact on increasing health care services in vulnerable populations (Anand et al., 2010; Rust et al., 2009; Shi et al., 2013). CHC patients were more likely to receive colorectal, breast and cervical cancer screening compared to patients at private physicians' offices and HMOs (Aldridge et al., 2006; Shi & Stevens, 2007). CHC patients also were more likely to receive flu vaccinations and to be prescribed inhaled steroids for asthma compared to patients at private health care providers (Hicks et al., 2006). Obtaining specialty health care services, such as addiction counseling or obesity management, remains a challenge for CHCs, as many patients lack the means to pay for specialty care services (Anand et al., 2010; Gilmer, Walker, Johnson, Philis-Tsimikas, & Unützer, 2008).

Improved management of chronic illness.

Poor management of blood sugar levels can result in productivity loss at work, reduced earnings, and increased risk for diabetes-related morbidity and mortality (American Diabetes Association, 2008). Coordinated medical management of elevated blood sugars becomes essential the longer an individual lives with diabetes. In CHCs, patients with diabetes were more likely to have an $HbA1_c$ checked and were more likely to return to have $HbA1_c$ re-checked in the

same year (Carson, Reynolds, Fonseca, & Muntner, 2010; Cowie et al., 2009). Patients who visit a CHC were more likely to see a CHC health care provider for follow-up appointments and were less likely to visit an ER or be subsequently admitted to a hospital (Proser, 2005; Shi et al., 2007). Researchers observed that in individuals with diabetes who used a CHC, a reduction in $HbA1_c$ from 8.7 to less than 8 percent was found, and patients with well-controlled hypertension went from 32 to 38 percent (Proser, 2005). CHCs positively impact chronic illness care, especially when every 1 percent reduction in $HbA1_c$ leads to a 14 percent reduction in heart attack and a 12 percent reduction in stroke risk (Proser, 2005).

Biological Influences

Obesity

Obesity affects approximately 66 percent of the adult population and increases risk factors for the development of prediabetes, T2DM, and cardiovascular disease (Centers for Disease Control and Prevention, 2007). The obesity epidemic has resulted in a paradigm shift regarding our understanding of adipose tissue. Commonly referred to as “fat” in humans, it was originally thought of as an inert form of energy storage. However, multiple studies demonstrated that fat, or white adipose tissue (WAT), acted more like an endocrine organ and influenced insulin sensitivity and glucose homeostasis (Abdul-Ghani & DeFronzo, 2010; DeFronzo, 2009; Leshan et al., 2006; Wajcberg et al., 2006). The detrimental effects of elevated cytokine secretion, also referred to as markers of inflammation, suggested that a link between obesity and cardiovascular disease also existed (Berg & Scherer, 2005; E. Rhee et al., 2012).

New terminology began to appear describing an association between pathogenic adipose tissue and metabolic disease and in an effort to better define this relationship, the word “adiposopathy” arose. In adiposopathy, adipose tissue cells enlarge and this results in an adverse

metabolic disease state (Bays et al., 2008; DeFronzo, 2004a; DeFronzo, 2009). It has been observed in WAT that macrophage gene regulation is upregulated, resulting in the production of cytokines, such as tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6). Researchers have suggested that WAT was associated with inflammation, as seen in several studies which demonstrated the majority of people with T2DM were overweight (Abdul-Ghani & DeFronzo, 2010; DeFronzo, 2004b; DeFronzo, 2009). However, whether adipose tissue becomes pathogenic or not depends in part on genetic predisposition and environmental surroundings.

In obese, glucose-tolerant people, and in those with impaired glucose tolerance, changes occur in cytokine production within WAT (DeFronzo, 2004a; Madec et al., 2011). In the WAT of people with metabolic syndrome, researchers observed an increase in both cellular adhesion molecule CD-40L and p-selectin concentrations compared to lean, healthy controls (Genc et al., 2011). Adhesion molecules, such as intracellular adhesion molecule-1 (ICAM-1) and vascular cellular adhesion molecule-1 (VCAM-1), allow monocytes to attach to endothelial cells, which can initiate atherosclerotic plaque formation. Once these monocytes have migrated into the sub-endothelial space, they differentiate into intimal macrophages, which take up lipids. When the macrophage has accumulated enough lipids, it is considered a foam cell, which is the prominent characteristic of atherosclerosis (Kaplan et al., 2012).

Disturbances in Neuroendocrine Activity

In his book, *The Stress of Life*, Hans Selye describes stress, how the body responds to it, and how adaptive responses can later result in illness. Selye referred to the adaptation to stress as the General Adaptation Syndrome (GAS). GAS is defined as all the non-specific changes that develop during continued exposure to a stressor (Selye, 1956). The GAS consists of three distinct stages: (a) the alarm reaction, (b) the stage of resistance and (c) the stage of exhaustion.

Selye referred to the illnesses of chronic stress as "diseases of adaptation." Illnesses in people exposed to chronic stressors were due to the expenditure of adaptation energy and finally exhaustion (Selye, 1956). In Selye's research with rats, he observed that stress frequently resulted in alterations in the function of particular organs, such as; (a) the hypothalamus, (b) the adrenal glands, (c) the stomach, (d) the lymphatic tissue and (e) white blood cells (Selye, 1956). Selye isolated a possible pathway through which an altered GAS led to illness, which was the excessive secretion of corticoid hormones.

The GAS ensures the survival of the organism and also preserves homeostasis. Homeostasis is defined as the ability to remain the same, or static, which requires energy (Selye, 1956). The GAS is designed to be limited in duration; however, in individuals under chronic stress, alterations occur in neuroendocrine pathways (Ahrens et al., 2008; Dettenborn et al., 2010; Wahbeh & Oken, 2013). Alterations in the adaptation response can result in increased blood pressure, increased evening cortisol levels, and increased insulin levels, which can contribute to an insulin-resistant state (Abraham et al., 2007; Chrousos, 2000; McEwen, 2006; Selye, 1956).

People suffering from sleep deprivation provide another example of the physiologic alterations in sympathetic nervous system/HPA activity under stressful conditions. Prolonged sleep deprivation is associated with increased appetite, increased pro-inflammatory cytokine production, decreased levels of leptin, and cognitive impairment (McEwen, 2006). The effect of exposure to chronic stressors can even lead to structural changes in the brain. In prolonged stress experiments with animals, atrophy of neurons in the brain was observed in regions involved with memory and selective attention. Hypertrophy of brain regions involved with fear and aggression

also were observed in animal models, and research with humans suggested similar brain re-modeling due to stress (McEwen, 2006).

Feelings of lack of control over one's life can mimic a chronically stressed state and the subsequent neuroendocrine adaptive response. The Whitehall longitudinal study was one of the first large cross-sectional studies suggesting that lack of control, as well as lower socio-economic status, led to increased risk of disease among British civil servants (Abraham et al., 2007). For the first time, researchers examined social determinants of health during the study and demonstrated important associations existed between pay grade and autonomic function. Researchers demonstrated that lower variability in heart rate was associated with disturbances in neuroendocrine activity, and the disturbances were attributable to stress (Brunner et al., 2002). Researchers demonstrated that employment grade was correlated with heart rate variability, which was a measure of cardiac autonomic activity. Low heart rate variability is a risk factor for cardiovascular disease and the researchers illustrated that psychosocial factors and obesity explained a significant part of adverse cardiac autonomic function (Brunner et al., 2002).

Immigrants to the U.S. experience stressors such as work stress and financial stress (Gallo, Jimenez, Shivpuri, Monteros, & Mills, 2011) and live in a heightened vigilant state, which may alter cortisol secretion (Flores et al., 2008). The stress of acculturation is associated with an attenuation of cortisol and alterations in cortisol awakening response (CAR) (Mangold et al., 2010), as evidenced by a negative association between time in the U.S. and CAR in Latino men (Squires et al., 2012). Both recent immigrants and Mexican Americans perceived the stress of acculturation (Farley, Galves, Dickinson, & Perez, 2005), however, acculturation level may offer some protection against perceived stressors. When adjusted for age, Mexican-American adults who had a more Anglo acculturation had a more blunted cortisol response when compared

to those with a more Mexican orientation (Kudielka & Kirschbaum, 2003; Mangold et al., 2010). Perceived stress affects younger Latinos as well. In obese Latino youth, an association was observed between cortisol and fasting glucose levels (Adam et al., 2010). This finding is significant, because the increase in baseline cortisol levels was later related to a decrease in insulin sensitivity at the one-year follow-up (Adam et al., 2010), suggesting that younger Latinos may be at risk of continued obesity as they grow.

HPA Exhaustion

Exposure to chronic stressors can create a continuously activated HPA and low levels of HPA activation may eventually exhaust the HPA's ability to respond. Researchers have suggested that the HPA axis can eventually lose normal function and become burnt-out. The concept of burnt-out HPA has been observed in populations under constant stress, as well as in persons with depressive illness (Abraham et al., 2007; Mangold et al., 2010; McEwen, 2006). An exhausted HPA also can no longer adequately respond to stressors, nor can the HPA be attenuated by a dexamethasone challenge, which is a test used to measure HPA function (Björntorp & Rosmond, 2000; Groschl, 2008; McEwen, 2006).

To examine the concept of an exhausted HPA, two groups of combat veterans were studied. Study participants were either diagnosed with post-traumatic stress disorder (PTSD) or without, and salivary cortisol samples were collected immediately upon awakening, 30 minutes after awakening and at bedtime. The PTSD group had diminished cortisol levels across all time points, even after adjusting for covariates of age, BMI, awakening time, depression or perceived stress (Wahbeh & Oken, 2013). HPA activity has been an area of long-standing interest in depression research, particularly the association between depression and T2DM, as cortisol secretory defects are considered a causal pathway for insulin insensitivity (Engum, 2007). In a

study involving women recovering from depression, a blunted cortisol response was seen when the participants were exposed to an acute stressor (Ahrens et al., 2008). While the researchers observed hypoactivity in HPA among women with depression, researchers posited that during remission from a depressive episode, the basal HPA activity may be reduced until time passes and recovery begins (Ahrens et al., 2008).

An exhausted HPA can increase risk of disease indirectly through altered eating patterns and subsequently lead to unintended weight gain. Animal studies suggested that a connection existed between an exhausted HPA axis and stress-induced eating (Björntorp, Holm, & Rosmond, 1999; Dallman et al., 2003; Dallman, Pecoraro, & la Fleur, 2005). HPA exhaustion, along with other neurotransmitters, may lead to disruption in cognition, alcoholism, anorexia, and anxiety (Bjorntorp & Rosmond, 1999; Chrousos, 2000). Under chronic stress conditions, Corticotropin Releasing Factor, Adrencorticotropin hormone, insulin, and glucocorticoids increase and concomitantly, so can the intake of comfort foods that reduce HPA activity (Dallman et al., 2005). Individuals may increase intake of preferred foods due to the pleasurable feedback from dopaminergic receptors in the brain (Dallman et al., 2003; Dallman et al., 2005). Other research suggests that sugar can alter neurological pathways in a way similar to drugs of abuse (Avena et al., 2008). Many of the observations with pleasurable food intake has been conducted in animals; however, the research suggests that a pathologic HPA can contribute to obesity, due to attenuated actions of leptin, as well as increases in the intake of pleasurable foods (Cason et al., 2010; Dallman et al., 2003; Sakurai, 2007).

Limitation of the Research on Diabetes Control in Latino Populations

There are several limitations in the research related to diabetes risk reduction behaviors among Latino populations. Lack of support from health care providers is one of the gaps in the

literature, particularly as a social influence in health-promoting behaviors in Latinos at risk. In the Health Promotion Model by Pender, there are three sources of social support: friends, family members, and healthcare providers (Pender et al., 2011). There is adequate support in the literature examining the effect of social support from family and friends. However, there is a limited amount of research on the influence of the healthcare provider on the health-promoting behavior of physical activity, especially when the nurse was the healthcare provider (Agazio & Buckley, 2010; Esposito & Fitzpatrick, 2011; Wambach, Domian, Page-Goertz, Wurtz, & HOffmann, 2016).

There continue to be gender differences in levels of physical activity among persons of Latino ethnicity. Latino women frequent report barriers to participating in physical activity due to child care responsibilities, demands from work and caring for extended family members (Kohlbry & Nies, 2009; Mier et al., 2007). Women also reported barriers to physical activity in the structural environment of the their neighborhoods, with concerns of poor lighting, poor sidewalks and fear of their safety (Mier et al., 2007).

Persons of Latino ethnicity bring to the U.S. their cultural practices, beliefs and language. As Latinos continue to live in the U.S., they undergo a process of acculturating to customs from the adopted culture, while retaining some cultural practices from their home country (Berry, 1988). Some of the cultural practices that Latinos retain from their country of origin are health-promoting, such as dietary habits and preferred leisure time physical activities. Previous research examined the effects of acculturation on dietary habits and leisure time physical activity among Latinos and found Latinos with low levels of acculturation have healthy dietary preferences (Ghaddar et al., 2010). However, previous researchers have also suggested that

Latinos with lower levels of acculturation have low levels of physical activity, which can increase their risk of chronic illness (Pérez-Escamilla, 2011).

The rapid adaptation to the cultural, economic and environmental practices of the U.S. can be a source of stress to persons of Latino ethnicity. It is possible that the cumulative stressors initiate a harmful physiological response, in the form of elevated blood pressure and disturbances in cortisol secretion, which contribute to T2DM development (Gallo et al., 2011). The increased level of stress can also lead to unhealthy coping patterns, such as increased fat and sugar intake and substance abuse (Rosal et al., 2011). Persons of Latino ethnicity perceive that unhealthy coping patterns, along with inadequate physical activity, are the main contributing factors in T2DM development (Castro-Rivas, Boutin-Foster, Milan, & Kanna, 2014). It is not clear whether the coping mechanisms employed by Latinos with low acculturation are simply overwhelmed by the stress of acculturating or whether Latinos accept T2DM as a matter of fate (Castro-Rivas et al., 2014).

Summary

The purpose of this literature review was to summarize the important factors that contribute to the genetic, molecular, acquired and environmental influences for developing T2DM. This review examined modifiable and non-modifiable risk factors, as well as the possible physiologic perturbations that also can contribute to illness. The HPA axis, under conditions of chronic stress, can result in elevated levels of cortisol and catecholamines, which can lead to increased glycogenolysis, gluconeogenesis, and mobilization of fat reserves that contribute to visceral obesity. These physiologic changes ultimately increase fasting glucose levels and decrease sensitivity to leptin and insulin.

Neuro-endocrine pathways were suggested initially as significant influences to blood glucose homeostasis by Claude Bernard in the 19th century. Bernard suggested that opposing neural pathways control metabolism and that blood sugar is increased and decreased according to the energy needs of the individual. The central nervous system can regulate glucose directly and indirectly through actions on tissues, as well as secretion of hormones that either increase appetite or decrease food intake. The CNS secretes counter-regulatory hormones, such as insulin, glucagon, epinephrine, and cortisol to indirectly regulate blood sugar levels and to respond to perceived stressors. The CNS is also an area of interest in addiction research, particularly in the desire of both illicit substances and food. Important neurotransmitters in the hypothalamus, such as orexin, ghrelin, and leptin, alter food intake and preferences. The concept of pleasure foods, or foods that induce feelings of relaxation and satiety after ingestion, suggests that the CNS could contribute to disordered eating patterns and obesity.

Genetic influences, non-modifiable risk factors, and psychosocial influences can contribute to T2DM risk and these conditions can exist either alone or in combination to increase risk. Modifiable risk factors can reduce T2DM risk, as well as maintain optimal health. Changes in lifestyle behavior can delay, and in some cases reverse, the sequence of events that lead to illnesses like T2DM. Changing health behaviors is challenging, yet structured interventions over time can help people incorporate healthy behaviors and maintain them. Future research needs to target the participants of DPP programs to determine participant benefits and barriers to health promotion, and to evaluate whether interventions can more effectively improve health outcomes.

CHAPTER THREE

Methods

Design

Type 2 Diabetes Mellitus (T2DM) is increasing at alarming rates within the Latino community, especially amongst immigrants as their time in the U.S. increases (Castro-Rivas et al., 2014; Kandula et al., 2008). This study explored differences in the health-promoting behavior of physical activity among immigrants with pre-diabetes/T2DM and those without pre-diabetes/T2DM within the Latino community using a cross-sectional, descriptive design. The dependent variable measured in this study was the level of the health-promoting behavior of physical activity, but will be referred to as physical activity from this point forward. The independent variables of the current study were acculturation, self-efficacy, and stress. Demographic characteristics (age, income level, diabetes status and educational status) were also measured. An adapted version of the health promotion model by Nola Pender was used as the theoretical framework to examine self-efficacy and how it related to health-promoting behaviors of adults within the Latino community (Appendix F).

Research Purpose

The purpose of this quantitative, descriptive investigation was to explore whether there was an association between acculturation, self-efficacy, stress and the health-promoting behavior of physical activity in Latino adults. A secondary aim was to identify whether there were differences in the health-promoting behavior of physical activity amongst Latino adults with pre-diabetes/T2DM and in Latino adults without pre-diabetes/T2DM.

Research Questions

1) How do Latino adults engage in health-promoting behaviors related to physical activity?

2) What are the differences in self-efficacy, stress and the health-promoting behavior of physical activity between Latino adults with pre-diabetes/Type 2 Diabetes Mellitus and Latino adults without pre-diabetes/T2DM?

3) What is the relationship between acculturation, self-efficacy, stress and the health-promoting behavior of physical activity among Latino adults?

4) What is the relationship between acculturation, self-efficacy, stress and the health-promoting behavior of physical activity amongst Latino adults with pre-diabetes/T2DM and Latino adults without pre-diabetes/T2DM?

Study Settings

The study took place at the location that was most convenient for the participants. Locations included Latino parishes in an urban, mid-western city. The parishes had large congregations of Spanish speakers, as well as smaller number of English speakers. Masses took place during the mid-morning on weekends and also during weekdays in the evenings. Additional locations included community health clinics and cultural centers located in pre-dominantly Latino communities, where English and Spanish speaking patients received healthcare and social services. Community sites were also used to recruit study participants. Another possible location to recruit Latinos was local community sites where Latinos gather, such as community health clinics and cultural centers. Community health clinics (CHCs) are federally funded medical clinics, with a focus on psychosocial services, bilingual and bicultural trained staff and employ a sliding fee structure to improve access to health care services (Shi et al., 2013). CHCs have implemented both educational programs, as well as behavioral support using collaborative approaches, to enhance health promotion among vulnerable populations.

Cultural centers are sites where Latinos gather to speak with friends, can gather for meals, as well as obtain health and legal advice.

Participant Sample

Participants were either Spanish or English speaking or bilingual. Participants self-reported that they had either T2DM, pre-diabetes, were informed by their health care provider that they were at risk for T2DM or did not have either T2DM or pre-diabetes.

Inclusion criteria

The inclusion criteria for participation was (a) individuals who self-identified as Latino, (b) spoke and read in Spanish or English, or was bilingual (c) was at least 18 years of age, (d) provided verbal consent to the researcher, and (e) was born either in Mexico, Central or South America or born in the U.S. with parents born outside of the U.S.

Exclusion criteria

Exclusion criteria was (a) younger than 18 years of age, (b) diagnosed by a physician with a mental illness and (c) had cognitive deficits that impaired reading and verbal responses.

Participant Recruitment

Latino adult community members were surveyed, with recruitment immediately taking place after mass at Latino parishes. An announcement in Spanish was made at the end of the mass by the researcher describing the survey. The researcher and other research team assistants individually distributed the surveys to the participants once mass ended. For community participants who were not comfortable completing the survey, the researcher or a research assistant assisted in administering the survey. Participants were given an opportunity to ask questions in either English or Spanish.

Data Collection Procedures

Internal review board approval was obtained from the University of Wisconsin Milwaukee IRB. Due to the sensitive nature of documentation status among Latino immigrants, and the fact that participants at the local parishes or community sites may be undocumented residents of the U.S., a waiver for signed consent form was obtained from the IRB. When working with community members recruited from Latino churches, written permission was obtained from the pastor of the participating parishes prior to the collection of data. A permission to contact form was requested in order to contact possible participants who were not able to complete the questionnaires after mass, and preferred to be contacted at home and complete the questionnaires via phone. A permission to contact form was requested to contact individuals at the community sites, such as the community health centers, for individuals who were interested in participating, but who were not able to do so at the time of initial contact.

All participants received a consent to participate form and questions from the participants were answered in Spanish by the student researcher (PI), however, study participants were not required to write their name and sign the informed consent form due to concerns that participants would be identifiable. Participants were given a written handout of the proposed study and a brief presentation was conducted in both English and Spanish by the PI. The PI also answered questions from participants, as the PI is a certified medical interpreter for Spanish.

Interested participants were asked to stay for approximately 15 minutes to have the study consent form read to them in Spanish. Participants were also given a copy of the informed consent form. Participants were allowed to ask questions of the researcher, and could decline to participate at any time. Once participants gave verbal consent to the researcher, participants then completed the psychometric instruments and the demographic questionnaire. For participants who were not comfortable completing the survey, the researcher or a research assistant assisted

in administering the survey in English or Spanish, based on the preference of the participant. Data collection was performed by the researcher, however in the event that a large number of potential participants responded, other PI-trained research assistants, who were also bilingual in English and Spanish, were available to assist in data collection.

Study participation was voluntary, and participants were informed that they could decline to participate at any point during the study, up until the time they submitted their surveys to the investigators. Participants were informed prior to handing in their surveys that as there will not be any names to identify the participants on the surveys, there would be no way for the investigator to remove their data at that point. The decision to participate or not in the study would not in any way affect any relationships with the parish or cultural centers or UWM.

The information gathered from the research study was completely confidential and would be de-identified. Only the researcher, major professor or committee members, and biostatistician had access to the de-identified information. The data collected would be saved on a password protected computer until the data had been analyzed and disseminated, and would be reported in aggregate form as group data. Completed questionnaires would be stored in a locked location at the UWM-College of Nursing for a period of 10 years. The risks that participants may experience were minimal, and there were no costs to the participants. Given that participation does take valuable time for the participant to complete, the participants were given a nominal remuneration of a $15.00 gift card for their time.

Study Instruments

The following instruments were used in the current study. The independent variable of Acculturation was measured with the Acculturation Rating Scale for Mexican Americans-II. The independent variable of self-efficacy was measured with the modified version of the

Diabetes Empowerment Scale. The independent variable of stress was measured with the Perceived Stress Scale and the dependent variable of the health-promoting behavior of physical activity was measured using the International Physical Activity Questionnaire.

Independent Variables

Acculturation

Health-promoting behaviors, such as healthy dietary intake and physical activity, have been linked to acculturation levels (Ghaddar et al., 2010). The dependent variable of acculturation was conceptually defined as the process persons go through while assimilating to a new language and culture. Acculturation was operationally defined by participant responses to Acculturation Rating Scale for Mexican Americans-II (ARSMA-II) (See Appendix A).

The ARSMA-II consists of two scales, the Mexican orientation scale and the Anglo orientation scale, with alphas of .88 and .83 respectively (Jimenez, Gray, Cucciare, Kumbhani, & Gallagher-Thompson, 2010). The ARSMA-II has been used previously when studying acculturation and cortisol levels in depressed Mexican participants with alpha levels ranging from 0.78 to 0.82 (Mangold et al., 2011; Mangold et al., 2010). In a study that examined acculturation in a culturally adapted diabetes intervention, the short version of the ARSMA-II was used, and demonstrated an association between Latina orientation and protective factors (i.e. lower saturated fat intake) and risk factors (decreased amount of physical activity) (Barrera Jr et al., 2012).

The ARSMA-II has been found to have strong construct validity and concurrent validity when measured against other acculturation measurement tools (Jimenez et al., 2010). Cuellar et al (1995) originally designed the tool to be used with Mexican populations, but the ARSMA-II has some cultural utility when used in other Hispanic groups (Cuellar, Arnold, & Maldonado,

1995). In the initial testing of the ARSMA- II, the scale had a correlation coefficient was .89, and construct validity was demonstrated by proportional increases in Anglo acculturation in subsequent generations, as predicted by the ARSMA-II (Cuellar et al., 1995). In a study with recently immigrated, Latino women, researchers found a significant negative correlation in the two subscales of -.60, and a subsequent factor analysis confirmed 2 acculturation solutions (Campos, Schetter, Walsh, & Schenker, 2007).

Scoring

Scale 1 of the ARSMA-II consists of two acculturative categories: A Mexican Orientation scale (MOS) and an Anglo Orientation Scale (AOS). Participants will be assigned a level upon completion of the scale, using the following total scores: Level 1 represents very Mexican orientation (mean <-1.33), level 2 represents Mexican oriented to Balanced Bicultural (mean ≥-1.33 and ≤ -.07), level 3 represents slightly Anglo Oriented Bicultural (mean > -.07 and <1.19), level 4 represents strongly Anglo Oriented Bicultural (mean ≥1.19 and < 2.45) and level 5 represents Very Assimilated Individual (mean >2.45) (Jimenez et al., 2010). Once the ARSMA-II is completed, the MOS mean score is subtracted from the AOS mean score, which then represents an individual score along a continuum from very Mexican orientated to very Anglo orientated.

Self-Efficacy

Self-efficacy is a central concept of Social Cognitive Theory and is an important variable to consider when examining an individual’s efforts at health behavior change. According to Alfred Bandura, self-efficacy is the belief that one can exercise control over one’s behavior (Bandura, 2005). Self-efficacy questions start with the statement, “In general, I believe that I,” emphasizing that individual mastery is essential (Hackworth et al., 2007). The dependent

variable of elf-efficacy was conceptually defined as the self-confidence that one has in their ability to change health behaviors when facing barriers or when facing challenging situations.

The DES-modified version was derived from the Diabetes Empowerment Scale by Robert Anderson (Anderson, Funnell, Fitzgerald, & Marrero, 2000) and the Stanford Patient Education Research Center, and is a valid measure of overall diabetes related psychosocial self-efficacy (Appendix B). The DES-modified version has been used previously in studies with persons at risk for diabetes (Hackworth et al., 2007; Kyrios et al., 2009). The DES has been successfully used in adults with T2DM (Bradshaw et al., 2007), depression (Bowser, Utz, Glick, Harmon, & Rovnyak, 2009) and underserved populations with diabetes (Ruggiero et al., 2010). In a study of vulnerable persons with T2DM, the researchers found the DES to be responsive to change as seen in increases in the empowerment score levels in the intervention group when compared to a control group (Ruggiero et al., 2010).

The DES-modified version was used previously in persons at risk for diabetes and researchers reported alpha levels for the exercise and diet self-efficacy scales were 0.87 and 0.91 respectively (Hackworth et al., 2007). In the same study with non-English speakers, researchers also reported that the Chinese version of the modified DES was 0.87 for both scales (Hackworth et al., 2007). The DES-modified version has not been used among Latino populations. The DES-modified version in this research study was translated into Spanish by a native Spanish interpreter and back-translated into English by a bilingual, bi-cultural Spanish speaker. The back translation process is considered a highly valid way to ensure semantic equivalence by preserving the original meaning (Polit & Beck, 2008).

Scoring

The DES-modified version is an 18-item, self-reported, ordinal scale questionnaire. The DES measures patient self-efficacy using two subscales of how confident persons are about engaging in exercise, and asks how they feel about maintaining a healthy diet under certain conditions. The questions all begin with the statement, “In general, I believe that I” followed by a series of statements. The individual item scores of the DES-modified version can range from 1-5, with higher scores indicating increased self-efficacy in one’s ability to take actions in diabetes self-care (Bowser et al., 2009).

Stress

Stress activates the nervous system, as the individual prepares to respond to the perceived threat. The central nervous system releases physiologic substances such as cortisol, norepinephrine, and epinephrine, which increases the availability of glucose to the cells, and leads to an increased sense of awareness (Sherwood, 2007). The independent variable of stress was conceptually defined as a negative emotional state generated by perceived threats and taxing demands. Stress was operationally defined by responses to the Perceived Stress Scale (PSS-14) (González-Ramírez et al., 2013) (Appendix C).

Previously the PSS-14 illustrated that Latinos, as well as other minority populations, reported higher levels of perceived stress (Flores et al., 2008; Gallagher-Thompson et al., 2006). In the initial research performed by the tool designer, Cohen (1983) demonstrated that PSS scores predicted the use of health services as well as perceived stress (Cohen, Kamarck, & Mermelstein, 1983). The PSS-14 demonstrated similar variability when compared to another established stress measurement tool, the Center for Epidemiological Studies-Depression scale (CES-D) (Gallagher-Thompson et al., 2006). The PSS-14 was designed to serve as a global measure of perceived stress. When the PSS was piloted as a potential research tool for

measuring stress, the researchers compared it to other established instruments such as the College Student Life-Event Scale, the Center for Epidemiologic Studies (a depression measure) and the Social Avoidance and Distress Scale (a measure of social anxiety). The PSS-14 was found to correlate positively with the Life-Event Scale, an independent stress measurement tool, with observed alpha levels of 0.85 and 0.86 in undergraduate students at public universities (Roberti, Harrington, & Storch, 2006).

Scoring

The Perceived Stress Scale (PSS-14) uses a Likert style format with respondents answering questions with 0 meaning 'never' and 4 meaning 'very often.' The PSS-14 uses statements that begin with "In the last month, how often have you," and has been used in Spanish speaking populations previously (González-Ramírez et al., 2013). The PSS-14 is comprised of both positive and negative items, with questions 4, 5, 6, 7, 9, 10 and 13 worded as positive items and 1, 2, 3, 8, 11, 12 and 14 as negatively worded items. Higher scores on the PSS-14 suggest higher levels of perceived stress.

Dependent Variable

The Heath Promoting Behavior of Physical Activity

Regular physical activity can delay the progression, and may even reverse the metabolic risk profile of T2DM (Borodulin et al., 2006; Gelaye et al., 2009; Ilanne-Parikka et al., 2010). The dependent variable of the health-promoting behavior of physical activity was conceptually defined as any bodily movement that caused contraction of skeletal muscle. The health-promoting behavior of physical activity was operationally defined by responses to the International Physical Activity questionnaire (I-PAQ) (See Appendix D). Responses were scored in MET minutes and were reported as MET mins/wk. A MET (Metabolic Equivalent of

Task) is a multiple of resting metabolic rate, and one unit of measure is scored as MET-minutes/week (Roman-Viñas et al., 2010).

The I-PAQ measures three types of activity: walking, moderate and vigorous physical activity. The I-PAQ tool has been used in diverse populations like playgroup mothers (Jones et al., 2013), Mexican Americans (McEwen et al., 2010) and ethnic Chinese (Kyrios et al., 2009). In a study with playgroup mothers, researchers found associations between participant stages of change in exercise and changes in physical activity scores, suggesting the I-PAQ tool can capture changes in physical activity (Jones et al., 2013).

To test the criterion validity of the I-PAQ, researchers compared MET mins/wk. scores along with accelerometers worn during a walking intervention. Participants wore the accelerometer for seven consecutive days during waking hours and completed the I-PAQ on the eighth day. Researchers compared the results with the data from the accelerometer and found a significant correlation between total physical activity, time spent on vigorous physical activity from the devices, and the self-reported data from the I-PAQ (Roman-Viñas et al., 2010).

Scoring

Scoring of the I-PAQ gives a continuous score with three levels of physical activity, low, moderate, and high and was reported as MET minutes. A MET-minute is calculated by multiplying the MET score of an activity by the minutes the activity was performed. Participants scoring in the low category are considered inactive, participants scoring in the moderate category exercise from 3-5 days in a week, and participants in the high category exercise 6 or more days per week, or completed 1,500 MET-minutes/week of total physical activity.

Demographic Questionnaire

The demographic variables examined during this study were age, sex, socio-economic status, level of education, type of employment (part-time or full-time), food security and number of years living in the U.S. Other demographic variables examined were where the participants were born, family history of diabetes, length of time taken to drive to work, and smoking status (See Appendix E).

Data Analysis

The studies' data analysis was used to answer the proposed research questions and validated the use of the psychometric measurement tools. Descriptive statistics were used to describe participant characteristics, and data analysis addressed the following research questions.

Research Question #1

How do Latino adults engage in health-promoting behaviors related to physical activity?

To analyze research question number one, responses to the I-PAQ questionnaire were examined from the members of the community parishes and community sites. Descriptive statistics were used to determine whether community Latinos engaged in the health-promoting behavior of physical activity, and at what levels (vigorous, moderate, walking and total number of MET mins/wk.).

Research Question #2

What are the differences in self-efficacy, stress and the health-promoting behavior of physical activity between Latino adults with pre-diabetes/Type 2 Diabetes Mellitus and Latino adults without pre-diabetes/T2DM?

To analyze question number two, responses from the Diabetes Self-Efficacy Scale-modified version, the Perceived Stress Scale and the I-PAQ questionnaire were used. Self-

efficacy, stress and the health-promoting behavior of physical activity level were correlated to each other using T-test and Mann Whitney-U for physical activity.

Research Question # 3

What is the relationship between acculturation, self-efficacy, stress and the health-promoting behavior of physical activity among Latino adults?

To analyze question number 3, bivariate correlations were used. The independent variables of acculturation, self-efficacy and stress were used to examine correlations to the dependent variable, the health-promoting behavior of physical activity.

Research Question #4

What is the relationship between acculturation, self-efficacy, stress and the health-promoting behavior of physical activity amongst Latino adults with pre-diabetes/T2DM and Latino adults without pre-diabetes/T2DM?

To analyze question number 4, hierarchical multiple regression was used. After adjusting for age and gender, the contributions of the independent variables acculturation, self-efficacy, stress and diabetes status were evaluated for the percent of variance explained. Further analysis was performed by stratifying the sample by participants with T2DM/Prediabetes and participants without and a hierarchical regression was performed for each of them.

Ethical Conduct of Research

The informed consent process was conducted with a convenience sample of Latino community members. If the community members were also willing to also participate in the study, they were then to be enrolled in the study.

Summary

This was a quantitative, descriptive study of community Latinos who either have T2DM, have pre-diabetes, were told they were at risk for T2DM, or do not have either. The results from this study may not be generalizable to other Latinos living in other cities or communities. The parishes were located in predominantly Mexican enclaves, so acculturation levels from this study may not reflect the acculturation status of other Latino subgroups from Central or South America. As the data are cross sectional, the findings from this study represented a conservative estimate of the strength and significance of the independent variables on the dependent variable. Another possible threat to validity was history, due to the current scrutiny of immigration and uncertain legal position of Latinos in the U.S. which could have affected mass attendance, and willingness to participate in research even with the above stated protections.

This study was important because it was the first study to examine the effects of acculturation, self-efficacy and stress on the health-promoting behavior of physical activity in Latino populations with pre-diabetes/T2DM and in Latinos without. This study will contribute to the discipline of nursing by demonstrating that self-efficacy and acculturation levels can affect health-promoting behaviors. Additionally, this study will be important in the public policy arena. President Obama has authorized additional financial support to increase access to health care services for at-risk populations through increased funding for local community clinics. While politically uncertain at this time, the Affordable Care Act of 2010 included an increase in funding to expand services at community health clinics at 75 health centers across the U.S. (U.S. Department of Health and Human Services, 2016). Increasing access to health care services is vitally important to the local community as many community members live nearby and face barriers to health care access. Additionally, increasing scrutiny of immigration status among

Latinos, as well as threat of deportation, may foster a sense of anxiety among members of the community, furthering limiting health-promoting activities. Health care providers will be able to use the data from this research to understand how stress and acculturation affect health-promoting behaviors in the Latino community, and also to seek further funding in support of diabetes risk reduction activities.

CHAPTER FOUR

Results

This chapter provides the specific findings to each of the four research questions for this investigation. The study was guided by the following questions:

1) How do Latino adults engage in health-promoting behaviors related to physical activity?
2) What are the differences in self-efficacy, stress and the health promoting behavior of physical activity between Latino adults with pre-diabetes/Type 2 Diabetes Mellitus and Latino adults without pre-diabetes/T2DM?
3) What is the relationship between acculturation, self-efficacy, stress and the health-promoting behavior of physical activity among Latino adults?
4) What is the relationship between acculturation, self-efficacy, stress and the health-promoting behavior of physical activity amongst Latino adults with pre-diabetes/T2DM and Latino adults without pre-diabetes/T2DM?

Participants for this investigation were Latino, recruited from the community, and received informed consent documentation which assured that completing the surveys was voluntary, and participants did not have to answer any questions to which they were not comfortable responding. The self-report surveys were given to adults who identified whether they were diagnosed with pre-diabetes/Type 2 Diabetes Mellitus (T2DM), were informed by their health care provider that they were at risk for T2DM, or did not have either pre-diabetesT2DM. Frequencies and descriptive statistics are presented for the study sample. Participant demographics and non-parametric tests were used to answer question number 1. Bivariate correlations performed with SPSS (Version 23) were used to answer question number 2. Multiple regression analysis was used to answer questions 3 and 4.

The purpose of this study was to explore whether there was an association between acculturation, self-efficacy, stress and the health promoting behavior of physical activity in Latino adults. A secondary aim was to identify whether there are differences in the health promoting behavior of physical activity amongst Latino adults with pre-diabetes/T2DM and Latino adults without pre-diabetes/T2DM. In this study, the potential confounding effects of stress, acculturation, and self-efficacy on health-promoting behaviors were also examined.

Description of the Sample

Participants for this investigation were 195 Latino adults who completed the surveys. A majority of participants were female (66%), 24% were male, and 14 participants did not report their gender. The age of the 195 participants ranged from 18-76 years, with a mean age of 42.1 (*SD*=11.94) (see Table 1).

Table 4.1
Demographic Characteristics (*N* = 195)

Variable	*N*	%
Gender		
Male	48	27
Female	129	73
Ethnicity		
Latino	183	98
Employment Status		
Full time	81	48
Part time	34	20
Unemployed	52	31
Educational level		
Elementary school	55	28
Junior high school	24	12
High school	55	28
Associates degree	12	6
College/University	31	16
Annual income/year		
Less than $10,000	40	20
$10,001-$20,000	43	22
$20,001-$30,000	33	17
$30,001-$40,000	20	10
$40,001-$50,000	14	7
$50,001 or more	9	4
Birth place		
Outside of the US	144	73
Inside the US	27	13
Countries of origin		
Mexico	129	66
Peru	10	5
Puerto Rico	7	3
Dominican Republic	7	3
Guatemala	1	1
Costa Rica	1	1
Argentina	1	1
USA	4	2
Years living in the US		
Less than 5 years	23	11
Less than 10 years	145	74
More than 10 years	9	4
Driving distance to food		
Less than 1 mile	129	77
Less than 5 miles	32	16
Less than 10 miles	13	5
Driving time to work		
Less than 30 minutes	98	50
More than 30 minutes	16	8
More than 60 minutes	3	1

Variable	*N*	%
Smoking status		
Current smoker	16	8
Former smoker	20	10
Non-smoker	142	72
Family members with T2DM		
Father	39	20
Mother	60	31
Brother	17	8
Sister	25	12
Grandfather	15	7
Grandmother	26	13

Note: Percentages may not equal 100% due to rounding and missing values.

One hundred and thirty-seven of the participants in this study completed the I-PAQ instrument. As the focus of the I-PAQ was on physical activity, participants who selected “Don’t know/Not sure” in either vigorous or moderate physical activity domain (*n* = 49), and participants (*n* = 9) who did not complete the physical activity measurement tool, were not included in the analysis of the survey. There were participants (*n* = 6) who did not indicate the number of days of vigorous physical activity they performed, but did indicate the length of time exercising, and these participants were coded as exercising 1 day of vigorous physical activity. Participants who completed the I-PAQ questionnaire (*n* = 137) were not found to differ significantly on their reported acculturation, self-efficacy or stress from persons (*n* = 58) who did not complete the physical activity instrument (Martyn-Nemeth et al., 2010).

Participant surveys (*n* =137) that included both the number of days per week and daily time for either vigorous, moderate or walking activity were included in the analysis. Responses that provided hours and minutes for vigorous, moderate and walking physical activity were converted into total minutes for each activity, and were summed for a total number of MET mins/wk. Surveys where the participants (*n* =33) indicated participating in less than 10 minutes per day of either vigorous, moderate or walking physical activity were re-coded into zero for that activity. All cases where the amount of time spent walking, moderate and vigorous physical

activity exceeded 180 minutes per day were statistically transformed to reduce the possible effect of potentially misleading outliers (e. g., winsorized) to 180 minutes. The winsorized minutes allowed for a maximum of 21 hours to be reported for each activity level in a week. After all of the adjustments were made based on the responses to the survey, the final number of the I-PAQ questionnaires used for data analysis was 137.

An Adapted Theoretical Model

An adapted theoretical model based on the work by Nola Pender guided the current study and consisted of three central concepts: individual characteristics, behavior specific cognitions and the outcome behavior. In the Health Promotion Model by Pender, personal factors can be biologic, psychological or sociocultural, and behavior specific cognitions are also important because they serve as essential motivators (Pender et al., 2011). During this study, the following personal factors were measured: acculturation, educational level, socio-economic status (SES) and self-reported stress level. The adapted theoretical framework for this research was tested as a part of this study (Figure 1).

Personal Factors

The Brief Acculturation Rating Scale for Mexican-Americans (ARSMA-II) was used to measure the participant level of acculturation, which is an important characteristic to consider when working with Latino community members. Participants were placed into categories based upon the following total scores: very Mexican orientation (<-1.33), Mexican oriented to Balanced Bicultural (≥ -1.33 *and* $\leq -.07$), slightly Anglo Oriented Bicultural ($> -.07$ *and* <1.19), strongly Anglo Oriented Bicultural (≥ 1.19 *and* < 2.45) and Very Assimilated Individual (>2.45) (Jimenez et al., 2010). The alpha level for the ARSMA-II scale during this investigation was .676.

Participants in this investigation ($N = 195$) were predominately Latino (93%) with 0.5 percent self-identifying as being from another ethnic group. The majority of the respondents were born outside of the US (84%) with 66% of the participants reporting they were born in Mexico. Many of the participants shared that they were newly immigrated with 82% of the respondents residing in the US for less than 10 years. The mean ARSMA-II score for the respondents was -1.64, suggesting the participants were "very Mexican" in orientation. When examining the effect of level of acculturation alone on levels of physical activity, no significant correlation was observed ($p = .229$). No significant correlation was found between the respondent's level of acculturation and social support ($p = .495$). No significant correlation was found between the participant's acculturation level and barriers to health promotion, which in the current study were travel time to work ($p = .744$) and the distance required to travel to obtain fresh foods ($p = .793$).

Almost a third of the participants attended elementary school (32%) and high school (31%), along with 17% of the respondents being college-educated. Nearly half of the participants worked full time (49%) with almost a third reporting that they were unemployed (31%). The socio-economic status (SES) of the participants was measured using annual income and was divided into 6 categories: Less than $10,000 dollars per year, between $10,001-$20,000, between $20,001-$30,000, between $30,001-$40,000, between $40,001-$50,000 and greater than $50,001. A majority of the participants (71%) reported earning less than $30,000 per year, and with 25% of the sample reported earning less than $10,000 per year. In the adapted theoretical model, a Chi-Square test was used to examine correlations between SES and educational level on the dependent variable, physical activity. No significant correlations were observed between

SES and physical activity, (p = .593) or in educational level and physical activity (p = .525) in the current study.

Participants' self-reported stress levels were measured using Cohen's Perceived Stress Scale (PSS), a 14-item measure addressing the stress of life events (González-Ramírez et al., 2013). Responses to the 14 questions were added together for a total stress score, which can range from 0-56. The total stress score for all participants was 23.23 (*SD*=8.37), with an alpha level for the Perceived Stress Scale for this study of .690. A Chi-Square test was conducted to examine correlations between stress and physical activity; however, no significant correlations were found between the respondents' stress and their health promoting behaviors of physical activity (p = .403).

In the current study, interpersonal influences in the adapted theoretical model were measured by the responses to the following questions: "Did a healthcare provider tell you that you are at-risk for diabetes or have diabetes" and "do you have a family member with diabetes"? The relationship between personal factors and interpersonal influences was examined by conducting a bivariate correlational analysis. To examine whether SES or educational level correlated with having a family member with pre-diabetesT2DM, bivariate correlations were performed. There were no significant correlations found between SES and having a family member with pre-diabetes/T2DM, (p = .925) or in educational level and having a family member with pre-diabetes/T2DM (p = .722). Socio-economic status (SES) and educational level were examined to see if those variables were correlated with having a healthcare provider (HCP) tell you that you were at risk for pre-diabetes/T2DM. No significant correlations were found regarding SES and being at risk for pre-diabetes/T2DM (p = .199) or in educational level and pre-diabetes/T2DM (p = .907).

Behavior Specific Cognitions

Important behavioral cognitions explored during this study were perceived barriers to action, perceived self-efficacy, and interpersonal influences. Barriers to action were defined as driving distance to work (measured in minutes) and distance from a store that sold fresh fruits and vegetables (measured in miles). Approximately 66% of the participants in the study (N = 195) spent less than 30 minutes driving to work and approximately 10% spent less than 60 minutes to drive to work. Seventy-seven percent of the participants (N = 195) lived less than one mile from a store that sold fresh fruits and vegetables. In the current study, there was no association between driving distance to work and physical activity (p = .978) or in distance to obtain healthy foods and physical activity (p = .209).

Perceived self-efficacy was measured using the modified version of the Diabetes Empowerment Scale, which asked individuals how confident were they to perform health-promoting behaviors under various circumstances. The Diabetes Empowerment Scale (DES)-modified version was comprised of two subscales, the DES-Eat subscale (α = .815) and the DES-Exercise subscale (α = .703). In the current study, the reliability level for the total DES scale was .816 for all 18 items, comparable to previous use of the instrument (Hackworth et al., 2007). In the current study, there were no significant correlations between a participant's perceived self-efficacy and barriers to action (p = .789).

For the purposes of this research study, sources of interpersonal influences were if the participant had a family member with diabetes and if a health care provider told them they were at risk for diabetes or they were overweight. Interpersonal influences are cognitions that involve the beliefs or attitudes of others, primarily family members, peers or health care providers, and were measured by responses to a pre-diabetes questionnaire. To increase clarity from this point

forward, interpersonal influences will be referred to as social support. Participants were also asked to select whether immediate family members had been diagnosed as diabetic, such as, father, mother, brother, sister, grandfather or grandmother. The majority of the participants reported they were not diabetic (80%), though 56% reported having been informed by their health care provider they were at risk for diabetes. A majority of the participants (61%) reported having at least one family member with T2DM. When asked about family history of diabetes, many participants identified their mother as having diabetes (31%) followed by their father (20%), grandmother (13%) and sister (12%). In the current study, there were no significant correlations between social support and physical activity (p = .596).

Participants reported having discussions with their health care providers about their own diabetes risk. Participants who were told that they were at risk for diabetes were significantly more likely to report also being told they were also pre-diabetic (p = .000). Significant correlations were seen among respondents who were told by their healthcare provider that they were at risk for diabetes and that they were overweight (p = .000). An association was also seen between participants who reported having a family member with diabetes, and being told they were overweight (p = .012) or were at risk for diabetes (p = .003).

Behavioral Outcomes

In the adapted theoretical model used in the current study the outcome was the health promoting behavior of physical activity. Physical activity was measured as the number of MET mins/wk. of vigorous, moderate or walking activities performed per day over the past 7 days. Physical activity was measured using the International Physical Activity Questionnaire (IPAQ). The IPAQ tool measures physical activity by Metabolic Equivalency of Tasks (METs), which are defined as the resting metabolic rate or the amount of oxygen consumed at rest (Jette, Sidney,

& Blümchen, 1990). The MET formulas used to compute the domains of walking, moderate and vigorous activity of MET-mins/wk. were as follows: Walking MET-mins/wk. equaled 3.3 * walking minutes * number of walking days, Moderate MET-mins/wk. equaled 4.0 * moderate activity minutes * number of moderate days and Vigorous MET –mins/wk. equaled 8.0 * vigorous activity minutes * number of days of vigorous activity. The total number of MET mins/wk. per participant was the sum of walking MET mins/wk. + moderate MET mins/wk. + vigorous MET mins/wk.

Research Question One

How do Latino Adults Engage in Health-Promoting Behaviors Related to Physical Activity?

The median number of MET mins/wk. for all participants with completed physical activity surveys (*n* =137) was as follows: 2160 MET mins/wk. of vigorous physical activity, 1140 MET mins/wk. of moderate physical activity and 1386 MET mins/wk. of walking (Table 4.2). The total number of MET mins/wk. for the study sample was 5430 MET mins/wk., which equates to 648 MET minutes per day of physical activity from work, leisure, domestic and walking activities (See Table 4.2).

Table 4.2

The Health Promoting Behavior of Physical Activity in MET mins/wk. by Domain (*n* = 137)

Activity	Mean Minute	(*SD*)	Median Minute	Median MET mins/wk.
Vigorous	162	(176.81)	112	2160
Moderate	132	(123.84)	90	1140
Walking	130	(135.16)	90	1386
Total	397	(309.77)	315	5430

Note: Physical activity values represent activity over the last seven days. MET mins/wk will be reported as median values, all other variables as mean values. METs are Metabolic Equivalency of Tasks. *SD*=Standard Deviation

The lowest of the three activities was moderate physical activity at 1140 MET mins/wk. Participants participated in a total number of 5430 MET mins/wk. (Table 4.2). A statistically significant correlation was found between participant's level of vigorous MET mins/wk. and total number of MET mins/wk. ($\chi^2(137) = .914$, $p = .036$).

A significant correlation between age of the participants and physical activity suggested that younger persons performed a greater number of vigorous MET mins/wk. when compared to older persons (42 and older) ($p = .041$). Older participants preferred walking to moderate physical activity; however, when compared to younger participants, the difference was not statistically significant ($p = .989$).

Examination of physical activity by gender suggested that Latino men engaged in significantly more vigorous physical activity than Latino women, ($t\ (137) = 3.718$, $p > .000$, $d = 3.78$). Men reported engaging in 3600 vigorous MET mins/wk. when compared to 1920 MET mins/wk. in women. No significant difference was seen in moderate physical activity, where men engaged in 1440 MET mins/wk. compared to 960 MET mins/wk. in women ($p = .255$). When the number of MET mins/wk. seen in walking was examined by gender, no significant differences were found ($p = .368$). The total number of METS mins/wk. was higher for men, with men engaging in 7359 MET mins/wk. compared to women with 5208 MET mins/wk. ($t\ (137) = 3.110$, $p = .002$, $d = 3.10$).

In the current study, 48% of participants worked full-time, 20% worked part-time and 31% were unemployed. A One-way ANOVA demonstrated differences in physical activity based on employment status, suggesting that employment status had an effect on physical activity. Significant differences were observed in vigorous MET mins/wk. based on employment

status, F (2, 106) =11.52, p = .000, and in the total number of MET mins/wk., F (2, 122) = 11.13, p = .000.

Years living in the US did not appear to have an effect on MET mins/wk. No significant difference was found in vigorous, moderate, walking or total number of MET mins/wk. among those who lived in the US for less than 5 years, more than 5 years, or more than 10 years. There were also no differences found in MET mins/wk. by the participant's educational level.

The major research findings for research question one are that persons of Latino ethnicity did engage in the health promoting behavior of physical activity. There was also gender effect in participation in physical activity, as well as an effect of age on physical activity. There was a significant effect of employment status on physical activity.

Research Question 2

What were the differences in self-efficacy, stress and the health promoting behavior of physical activity between Latino adults with pre-diabetes/Type 2 Diabetes Mellitus and Latino adults without pre-diabetes/T2DM?

In the current study, there were 40 participants (32 females, 6 males) with pre-diabetes/T2DM, and 136 participants (96 females, 40 males) without pre-diabetes/T2DM. An additional 19 participants did not indicate whether they were diagnosed with T2DM or had pre-diabetes and 2 with pre-diabetes/T2DM who did not select a gender response.

A comparison of the pre-diabetes/T2DM group with the non-pre-diabetes/T2DM groups was made using a Mann-Whitney U statistical test. A statistically significant difference in the 2 groups was found, based on their age (p = .000). Therefore, to further examine the difference in the age variable between the 2 groups, a T-Test was conducted. Study participants with pre-

diabetes/T2DM were significantly older 50.2 (*SD* = 11.76) years when compared to participants without pre-diabetes/T2DM 39.7 (*SD* = 10.89) (p = .007) (Table 4.3).

Table 4.3

Differences in Physical Activity, Self-Efficacy and Stress by Diabetes Status (*N* = 195)

Variable	With T2DM/Pred (*SD*)	Without T2DM/Pred (*SD*)	Difference Between Groups
Participants (*N*)	40.0	136.0	
Age**	50.2 (11.76)	39.7 (10.89)	.000
Self-efficacy	3.19 (.59)	3.05 (.45)	.222
Stress	23.27 (9.47)	22.93 (8.08)	.823
Vigorous	1440.0	1600.0	.382
Moderate	720.0	840.0	.909
Walking	1188.0	1108.0	.615
Total Physical Activity	4022.2	4320.0	.365

Note: Mean scores reported for the independent variables. Physical activity domains reported as median MET mins/wk. * $p < .05$, ** $p < .01$, ns = not significant.

T-tests were conducted to examine if there were differences in the physical activity domains by participant's diabetes status. Participants with pre-diabetes/T2DM participated in lower levels of physical activity in all domains except for walking. However, none of the differences in the physical activity domains was statistically significant between the two groups (See Table 4.3).

Participants with pre-diabetes/T2DM reported having higher levels of self-efficacy compared to participants without; however, the difference was not significant (p = .222) (Table 4.3). To examine differences in self-efficacy between the participants based on diabetes status, a Mann-Whitney U test was performed, and there were no differences found in self-efficacy scores between the 2 groups. Stress levels in participants with pre-diabetes/T2DM were not found to be significantly different than in participants without pre-diabetes/T2DM (Table 4.3). When the stress scores were examined by gender, the stress scores for males (22.38, SD = 9.2) were not significantly different from the scores for females (23.51 SD = 8.3) (p = .440).

The major findings of research question number two was that Latinos with pre-diabetes/T2DM did engage in physical activity, and at the same level as Latinos without. Another significant finding was that Latinos with pre-diabetes/T2DM were significant older than Latinos without. There was no other significant difference seen between the two groups.

Research Question 3

What was the relationship between acculturation, self-efficacy, stress and the health-promoting behavior of physical activity among Latino adults?

The instruments used in the current study to measure the independent variables were observed to have alpha levels of .80 or higher, with the exception of the Diabetes Empowerment Subscale for Exercise (DES-Exercise) (α = .702) and the total Acculturation Rating Scale for

Mexican Americans-II (ARSMA) (α = .676). In the current study, the two subscales of the ARMSA-II, Anglo Orientation Scale (AOS) and Mexican Orientation Scale (MOS) had alpha levels of .87 and .806, respectively (Table 4.4).

Table 4.4

Means of Acculturation, Self-Efficacy, and Stress (*N* = 195)

Variable Acculturation	Score	Standard Deviation	Alpha
AOS	2.64	1.06	.870
MOS	4.32	.74	.806
Total ARMSA-II	-1.68	1.43	.676
Self-Efficacy			
DES-Eat Subscale	2.85	.79	.809
DES-Exercise Subscale	3.43	.80	.702
Total DES score	3.14	.68	.814
Stress	23.11	8.42	.803

Note: AOS=Anglo orientation scale, MOS=Mexican orientation scale, ARSMA-II=Acculturation Scale for Mexican Americans, PSS-14=Perceived Stress Scale (14-items), SE=Self-Efficacy, DES=Diabetes Empowerment Scale-Modified Version.

Relationships between the dependent and independent variables were examined using bivariate correlations. An analysis was performed to examine if a relationship existed between the independent variables of acculturation and stress, however no significant correlations were found ($r = -.005$, $p = .819$). There were no significant correlations between stress and the physical activity domains of vigorous, moderate, and walking (Table 4.5). There was a significant negative correlation between stress and the total number of MET mins/wk. ($r = -.170$, $p = .02$). There was also a significant correlation between stress and the self-efficacy exercise subscale ($r = -.170$ $p = .019$) (Table 4.5).

There were significant correlations between total number of MET mins/wk. and the physical activity domains of vigorous, moderate, and walking. The total number of MET mins/wk. was positively correlated with vigorous, moderate, and walking physical activities (Table 4.5). There were no significant associations between any of the domains of physical activity and self-efficacy (Table 4.5). Acculturation was not associated with any of the domains of physical activity. Self-efficacy was not associated with either vigorous, moderate, or walking physical activities. There were significant associations between the self-efficacy subscales of eating and exercise, ($r = 0.368$, $p = .01$). There was no significant correlation between self-efficacy and acculturation ($r = .113$, $p = .334$). Because there were no differences between participants who completed the I-PAQ questionnaire when compared to those who did not, all of the surveys were included to answer research question 3. With the exception of Tables 4.4, 4.5 and 4.6, the number of participants used in analysis was 137, so the reported values in Table 4.5 might have been lower if 137 participants were used.

Table 4.5

Bivariate Intercorrelations for Dependent and Independent Variables (*N* = 195)

Variables	1	2	3	4	5	6	7	8	9
1. Stress	-								
2. Self-Efficacy	-.106	-							
3. Acculturation	-.005	.113	-						
4. Vigorous	-.121	-.035	.051	-					
5. Moderate	-.105	.063	.031	.172*	-				
6. Walking	-.083	.010	.065	.380*	.278**	-			
7. Total Physical Activity	-.170*	-.005	.081	.911*	.501**	.654**	-		
8. Self-Efficacy Eating Subscale	-.036	.902**	.049	-.100	.041	-.007	-.073	-	
9. Self-Efficacy Exercise Subscale	-.170*	.730**	.152	.093	.104	.041	.115	.368**	-

* Correlation is significant at the 0.05 level.
** Correlation is significant at the 0.01 level.

The major findings of research question number three was that no associations were seen between the independent variables. There was a significant association between walking and both vigorous and moderate physical activity. There was a significant association between the total number of MET mins/wk. and stress.

Research Question 4

What was the relationship between acculturation, self-efficacy, stress and the health-promoting behavior of physical activity amongst Latino adults with pre-diabetes/T2DM and Latino adults without pre-diabetes/T2DM?

To analyze question number 4, hierarchical multiple regression was used. After adjusting for age and gender, the contributions of the independent variables of acculturation, self-efficacy, stress, and diabetes status were evaluated for the percent of variance explained in physical activity. The sample was also stratified by participants with pre-diabetes/T2DM versus participants without, and a hierarchical regression was used to examine the effect of having pre-diabetes/T2DM on physical activity.

There were no significant differences in the independent variables among Latinos who engaged in physical activity versus those who did not (Table 4.6). The independent variables of acculturation, self-efficacy and stress were entered in to the regression equation using a forward method to evaluate the variance that each variable added to the regression model. In the first model, the independent variable of acculturation was entered first, followed by the self-efficacy eating subscale, then the self-efficacy subscale, followed by stress. The regression model indicated that the self-efficacy subscale of exercise (SE-Exercise) was a significant predictor of physical activity in step 2 of the model, and that the overall model significantly predicted physical activity among the participants, F (4,130) = 2.708, p = .033 (Table 4.7).

Table 4.6

Independent Variable Means based on Physical Activity Status (N = 195)

Variable	Exercise Group	*SD*	No Exercise Group	*SD*	*t* (195)	*p*
Acculturation	-1.64	1.52	-1.77	1.18	-.544	.587
Self-Efficacy	3.08	.64	3.09	.70	.143	.886
Eating Subscale	2.79	.80	2.98	.76	1.52	.130
Exercise Subscale	3.47	.78	3.33	.84	-1.10	.270
Stress	23.09	8.29	23.15	8.8	.045	.143

Note: Acculturation was measured with the ARSMA-II scale, Self-Efficacy was measured using the DES-modified version, and Stress was measured with the PSS-14 Scale. Mean values are reported.

Table 4.7

Summary of Hierarchical Regression Analysis with Independent Variables as Predictors of Physical Activity among Participants with Stress entered last (n = 137)

	Step 1	Step 2	Step 3	
Variables	β	β	β	ΔR^2
Acculturation	.128	.085	.084	.016
SE-Eat		-.119	-.117	
SE-Exercise		.211*	.170	.040
Stress			-.147	.020
F (4,130) = 2.708, p = .033 Total R^2 = .077				

*Statistically significant $p < .05$. ** Statistically significant $p < .001$
Note: Dependent variable: Total physical activity in MET mins/wk. SE-Eat = Self-Efficacy Eating Subscale of the DES-modified version, SE-Exercise=Self-Efficacy-Exercise Subscale of the DES-modified version.

The variables age and gender were added in Step 1 of the regression model to examine their contributions to physical activity, followed by the variables of acculturation, self-efficacy subscales and stress. When age and gender were added to the model, both variables were negatively associated with physical activity (Table 4.8). The SE-Exercise subscale was significantly associated with physical activity when added in Step 3 ($r = .207$, $p < .05$). The model significantly predicted 11% of the variance in physical activity, F (6, 118) = 4.404, p = .000 (Table 8).

Table 4.8

Summary of Hierarchical Regression Analysis with Age, Gender and Other Independent Variables as Predictors of the Total Number of MET mins/wk. (n = 137)

	Step 1	Step 2	Step 3	Step 4	
Variables	β	β	β	β	ΔR^2
Gender	-.262*	-.258*	-.261*	-.250*	.110
Age	-.172*	-.159	-.179*	-.181*	
Acculturation		.099	.044	.044	.010
SE-Eat			-.077	-.076	
SE-Exercise			.245*	.207*	.050
Stress				-.123	.014

$F(6, 118) = 4.404$, $p = .000$ Total R^2 = .183

*Statistically significant P < .05. ** Statistically significant P < .001
Note: Dependent variable: Total physical activity in MET mins/wk. SE-Eat = Self-Efficacy Eating Subscale of the DES-modified version, SE-Exercise=Self-Efficacy-Exercise Subscale of the DES-modified version.

In the next regression model, diabetes status, age and gender were both negatively associated with physical activity and the SE-Exercise subscale was positively associated with physical activity (Table 4.9). After adjusting for age and gender, neither the independent variables nor diabetes status predicted physical activity among the study participants. The regression model significantly predicted 3.5% of the variance in physical activity, F (7, 115) = 3.268, p = .003 (Table 4.9).

Table 4.9

Summary of Hierarchical Regression Analysis with Age, Gender, Diabetes Status and Other Independent Variables as Predictors of Total Number of MET mins/wk. (n = 137)

	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	
Variables	β	β	β	β	β	β	β	ΔR^2
Age	-.188*	-.156	-.146	-.140	-.161	-.163	-.182*	.035
Gender		-.236*	-.233*	-.213*	-.217*	-.208*	-.221*	.055
Acculturation			.078	.083	.027	.027	.032	.006
SE-Eat				-.088	-.167	-.164	-.168	.007
SE-Exercise					.250*	.224	.221*	.053
Stress						-.088	-.087	.007
Diabetes Status							.063	.003

$F(7, 115) = 3.268$, $p = .003$ Total $\mathbf{R^2}$ = .166

*Statistically significant $p < .05$. ** Statistically significant $p < .001$
Note: Dependent variable: Total physical activity. SE-Eat = Self-Efficacy Eating Subscale of the DES-modified version, SE-Exercise=Self-Efficacy-Exercise Subscale of the DES-modified version.

In Tables 4.10 and 4.11, the multiple regression steps were repeated separately for the two diabetes groups to examine the contribution of being diagnosed with either pre-diabetes/T2DM on physical activity. In the next model, gender added to the variance among participants without pre-diabetes/T2DM; however, age did not. In step 6, both self-efficacy subscales, and stress significantly predicted physical activity among participants without pre-diabetes/T2DM, F (6, 89) = 6.008, p = .000 (Table 4.10).

Table 4.10

Summary of Hierarchical Regression Analysis with Age, Gender and Other Independent Variables as Predictors of Total Number of MET mins/wk. in participants without pre-diabetes/T2DM (n = 137)

	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	
Variables	β	β	β	β	β	β	ΔR^2
Gender	-.171	-.164	-.163	-.161	-.201*	-.215*	.029
Age		-.219*	-.218*	-.188	-.184	-.167	.048
Acculturation			.095	.111	.050	.037	.009
SE-Eat				-.126	-.306*	-.305*	.015
SE-Exercise					.443**	.411*	.155
Stress						-.184*	.032
$F(6, 89)=6.008$, $p=.000$ Total $\mathbf{R^2}$ = .288							

*Statistically significant P < .05. ** Statistically significant P < .001
Note: Dependent variable: Total physical activity. SE-Eat = Self-Efficacy Eating Subscale of the DES-modified version, SE-Exercise=Self-Efficacy-Exercise Subscale of the DES-modified version.

Age significantly added to the variance in the regression model among participants with pre-diabetes/T2DM (Table 4.11). After adjusting for age and gender, none of the remaining variables predicted physical activity among the participants. Step 6 of the model significantly predicted physical activity among participants with pre-diabetes/T2DM, F (6,20) = 3.152, p = .024 (Table 4.11).

Table 4.11

Summary of Hierarchical Regression Analysis with Age, Gender and Other Independent Variables as Predictors of Total Number of MET mins/wk. in participants with pre-diabetes/T2DM (n = 137)

	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	
Variables	β	β	β	β	β	β	ΔR^2
Gender	-.207	-.100	-.113	-.108	-.089	-.109	.043
Age		-.567*	-.571*	-.574*	-.578*	-.610*	.310
Acculturation			-.034	-.042	.111	.058	.001
SE-Eat				-.044	-.022	-.024	.002
SE-Exercise					-.376*	.286	.121
Stress						-.136	.010
$F(6,20) = 3.152$, $p = .024$ Total $R^2 = .486$							

*Statistically significant $p < .05$. ** Statistically significant $p < .001$
Note: Dependent variable: Total physical activity. SE-Eat = Self-Efficacy Eating Subscale of the DES-modified version, SE-Exercise=Self-Efficacy-Exercise Subscale of the DES-modified version.

The sample was stratified by pre-diabetes/T2DM status and regression analysis was performed with the independent variables of acculturation, the self-efficacy subscales and stress. After adjusting for age and gender, only the regression models for total number of MET mins/wk. and vigorous MET mins/wk. were significant predictors among participants without pre-diabetes/T2DM, F (6,60) = 3.226, p = .008, and F (6,60) = 3.581, p = .004, respectively (Tables 4.12 and 4.13). In both models, the self-efficacy exercise and eating subscales predicted physical activity. Among the participants who participated in vigorous physical activity, gender was negatively associated with physical activity, but not in the total number of MET mins/wk. (Table 4.13).

Table 4.12

Summary of Hierarchical Regression Analysis with Age, Gender and Other Independent Variables as Predictors of ***Total Number*** *of MET mins/wk. Stratified by participants without pre-diabetes/T2DM (n = 137)*

	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	
Variables	β	β	β	β	β	β	ΔR^2
Gender	-.103	-.087	-.074	-.074	-.156	-.173	.011
Age		-.238	-.232	-.213	-.217	-.216	.056
Acculturation			-.135	.144	.055	.044	.018
SE-Eat				-.072	-.318*	-.318*	.005
SE-Exercise					.478*	.472*	.149
Stress						-.074	.005
$F(6,60) = 3.226$, $p = .008$ Total $\mathbf{R^2} = .244$							

*Statistically significant $p < .05$. ** Statistically significant $p < .001$
Note: Dependent variable: Total physical activity. SE-Eat = Self-Efficacy Eating Subscale of the DES-modified version, SE-Exercise=Self-Efficacy-Exercise Subscale of the DES-modified version.

Table 4.13

Summary of Hierarchical Regression Analysis with Age, Gender and Other Independent Variables as Predictors of ***Vigorou****s MET mins/wk. Stratified by Participants without pre-diabetes/T2DM (n = 137)*

	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	
Variables	β	β	β	β	β	β	ΔR^2
Age	-.126	-.105	-.102	-.102	-.185	-.204	.016
Gender		-.298	-.296*	-.287*	-.291*	-.289*	.088
Acculturation			.028	.033	.057	-.069	.001
SE-Eat				-.037	-.285*	-.284*	.001
SE-Exercise					.481*	.474*	.151
Stress						-.087	.007
$F(6,60) = 3.581$, $p = .004$ Total $R^2 = .264$							

*Statistically significant $p < .05$. ** Statistically significant $p < .001$
Note: Dependent variable: Total physical activity. SE-Eat = Self-Efficacy Eating Subscale of the DES-modified version, SE-Exercise=Self-Efficacy-Exercise Subscale of the DES-modified version.

Among participants with pre-diabetes/T2DM, only the domains of total number of MET mins/wk. and vigorous MET mins/wk. were significant, F (6, 12) = 3.581, p = .029, and F (6, 12) = 29.699, p = .000, respectively (Tables 4.14 and 4.15). In both regression models, gender was a predictor of physical activity. The regression models were repeated for both walking and moderate HBP/PA, and neither model was significant, F (6, 12) = .553, p = .759, and F (6, 12) = .498, p = .798.

Table 4.14

Summary of Hierarchical Regression Analysis with Age, Gender and Other Independent Variables as Predictors of ***Total Number*** *of MET mins/wk. Stratified by Participants with pre-diabetes/T2DM (n = 137)*

	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	
Variables	β	β	β	β	β	β	ΔR^2
Age	-.305	-.164	-.154	-.153	-.099	-.078	.093
Gender		-.714*	-.707*	-.707*	-.719*	-.686*	.490
Acculturation			.054	.053	.115	.172	.003
SE-Eat				-.005	.072	.090	.000
SE-Exercise					-.242	-.334	.048
Stress						-.130	.008
$F(6, 12)=3.581$, $p=.029$ Total R^2 = .642							

*Statistically significant $p < .05$. ** Statistically significant $p < .001$
Note: Dependent variable: Total physical activity. SE-Eat = Self-Efficacy Eating Subscale of the DES-modified version, SE-Exercise=Self-Efficacy-Exercise Subscale of the DES-modified version.

Table 4.15

Summary of Hierarchical Regression Analysis with Age, Gender and other Independent Variable as Predictors of ***Vigorous*** *MET mins/wk. Stratified by Participants with pre-diabetes/T2DM* (*n* = 137*)*

	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	
Variables	β	β	β	β	β	β	ΔR^2
Age	-.305	-.122	-.115	-.116	-.088	-.102	.093
Gender		-.928**	-.923**	-.923**	-.929**	-.950**	.827
Acculturation			.035	.036	.854	.030	.001
SE-Eat				.002	.519	.029	.000
SE-Exercise					-.121	-.061	.012
Stress						.085	.003
$F(6, 12)$=29.699 p=.000 Total R^2 = .937							

*Statistically significant p <.05. ** Statistically significant p <.001
Note: Dependent variable: Total HPB/PA. SE-Eat = Self-Efficacy Eating Subscale of the DES-modified version, SE-Exercise=Self-Efficacy-Exercise Subscale of the DES-modified version.

The major findings from research study were that self-efficacy predicted the variance in physical activity, however stress mediated the effect of self-efficacy. Gender and age significantly predicted the variance in physical activity when entered into the regression models, so the two variables remained as control variables. When diabetes status was entered into the regression model, self-efficacy remained a significant predictor of physical activity. Once the sample was stratified by diabetes status, among Latinos without pre-diabetes/T2DM, only self-efficacy added to the variance in physical activity. In Latinos with pre-diabetes/T2DM, only gender explained the variance in physical activity.

Summary

A total of 195 participants met the inclusion criteria and were included in the current study. An adapted theoretical model was described and tested, a descriptive analysis of the participants was presented, and a description of the variables that influenced health-promoting behaviors was analyzed. The adapted theoretical model was not predictive of health-promoting behaviors, as there were no significant correlations between the Personal Factors, or with the Behavior-Specific Cognitions in the outcome behavior of physical activity.

Participants who engaged in walking were more likely to engage in vigorous activity. Latino males engaged in significantly higher levels of physical activity overall when compared to females. Females preferred walking to other forms of physical activity. Participants with pre-diabetes/T2DM were significantly older than those without. Physical activity was significantly affected by employment status, in both the amount of moderate and overall levels of physical activity. Self-efficacy was significantly associated with physical activity among participants without pre-diabetes/T2DM. Gender was significantly associated with physical activity among participants with pre-diabetes/T2DM.

Stress and self-efficacy subscales predicted physical activity in participants without pre-diabetes/T2DM but not in participants with pre-diabetes/T2DM. In the stratified analysis, gender was a predictor of vigorous physical activity in participants without pre-diabetes/T2DM, but not in the total number of MET mins/wk. In the stratified analysis of participants with pre-diabetes/T2DM, gender was the only variable that predicted both vigorous MET mins/wk. and total number of MET mins/wk.

CHAPTER FIVE

Discussion

The purpose of this study was to explore whether there was an association between acculturation, self-efficacy, stress and the health-promoting behavior of physical activity in Latino adults. A secondary aim was to identify whether there were differences in the health-promoting behavior of physical activity amongst Latino adults with pre-diabetes/T2DM and in Latino adults without pre-diabetes/T2DM. Interpretation of the research findings, conclusions and implications are provided. Limitations to this investigation will also be discussed.

Here are the major findings that emerged from the research questions. In the current study, there were no associations seen between personal factors and physical activity. There were no associations between barriers to action and physical activity. There were no associations between barriers to action and self-efficacy. There were no associations between interpersonal influences/social support and physical activity. There were no differences in physical activity between Latinos with pre-diabetes/T2DM versus Latinos without pre-diabetes/T2DM. There were no differences in acculturation, self-efficacy and stress between Latinos without pre-diabetes/T2DM versus Latinos without.

Summary of Findings from the Adapted Theoretical Model

An adapted theoretical model, based on Pender's Model of Health Promotion, was tested as a part of the current study. In the adapted model, the theoretical constructs were personal factors, barriers to action, perceived self-efficacy, interpersonal influences and the outcome behavior. Associations between the theoretical constructs from the adapted model and the outcome behavior, physical activity will be discussed in the following sections. In the adapted theoretical model, the variables of acculturation, educational level, socio-economic status and

stress were used as personal factors and were examined for a possible influence on physical activity. The dependent variable in the current study was the health-promoting behavior of physical activity and from this point forward will be referred to as physical activity.

Personal Factors

Findings from the current study suggested that the personal factor of acculturation was not associated with the outcome behavior of physical activity. The acculturation level of participants in the current study, as measured by the ARSMA-II scale, was -1.64. According to the author of the ARSMA-II scale, scores below -.07 suggest that the individual has a more Mexican orientation (Cuellar et al., 1995). In a previous cross-sectional study carried out in the U.S. among Latino participants, researchers noted that individuals of Latino ethnicity with lower acculturation scores typically did not engage in physical activity (Ghaddar et al., 2010). Barrera et al. (2012) carried out a 2 & ½ day diabetes management intervention among females of Latino ethnicity with diabetes, and also saw that lower acculturated Latino females were mostly sedentary. However, in the study by Barrera et al. (2012), the mean age of participants was 57.1 years, with an average length of time with diabetes of 10 years, which may explain some of the sedentary behaviors seen in the study participants. Another possible explanation may be the educational level of the participants, which was not measured in Barrera et al. (2012), however, in Ghaddar et al. (2010), over half the participants had not finished high school.

In the current research, there was no significant relationship between educational level or socio-economic status (SES) and physical activity, not unlike the study conducted by Chilton et al. (2006). Chilton et al. (2006) conducted a cross-sectional survey among Latinos in the southeastern U.S. to measure diabetes knowledge. Here too, researchers found that there was a significant relationship amongst their participants, who did not finish high school, and who did

not engage in health-promoting behaviors (Chilton et al., 2006). However, Chilton et al. (2006) did observe a positive association between SES and physical activity among Latinos with low levels of acculturation. Researchers saw that as incomes increased, participants were more likely to engage in physical activity, unlike the participants in the current study (Chilton et al., 2006). However, in the study by Chilton et al. (2006) participants lived in North Carolina, which as a climate is more conducive to being physically active for more time during the year.

Findings from the current study did not show an association between SES and physical activity, which contrasted with previous research among U.S. immigrants (Yang et al., 2007). Yang et al. (2007) examined the health-promoting behaviors of Korean immigrants living in the U.S. and observed that immigrants with higher incomes engaged in more health-promoting behaviors. In the study by Yang et al. (2007) however, researchers noted that the study participants were more likely to be married. The presence of a spouse might provide increased opportunities to share in the housework responsibilities, and thus create more opportunities to engage in physical activity. Marital status was not measured as a part of the current study.

The findings from the current study did not demonstrate a relationship between reported stress level and physical activity. Comparing stress levels between participants in studies can be challenging, since there is no defined cut-off for what constitutes a high level of stress (Silveira et al., 2014). The stress level among participants in the current study was similar to scores from a previous study conducted by Gallagher-Thompson et al. (2006). Gallagher-Thompson et al. (2006) examined caregiver stress among Non-Latino Whites and persons of Latino ethnicity, and then stratified groups by both caregiver status and ethnicity. Latino non-caregivers had a mean stress score of 22.67 (SD = 7.0), which was lower than the mean stress score in the current study (Table 4). While participants in the current study reported stress, the findings suggest that the

participants did not have elevated levels of stress. It is surprising that the participants in the Gallagher-Thompson et al. (2006) study had similar stress scores when compared to participants in the current study, despite being older in age, 54 years versus 42 years in the current study. A possible explanation for similar stress scores may be that older persons had developed coping mechanisms or had support from families that attenuated caregiver stress.

Behavior Specific Cognitions

When barriers to health promotion are present, the desired health behavior can be perceived as more difficult, inconvenient or time-consuming, and subsequently will not be performed (Pender et al., 2011). In the current study, there were no significant associations between barriers to action and physical activity. In a previous study of breastfeeding behavior among women of Latino ethnicity, women reported that lack of time and returning to work were significant barriers in continuing to breastfeed (Wambach et al., 2016). Chilton et al. (2006) examined diabetes knowledge and health-promoting behaviors in a cross sectional analysis of Latinos with limited language skills. Here too, investigators found that when there were barriers in accessing illness prevention information, health-promoting behaviors were significantly impacted (Chilton et al., 2006).

According to the adapted theoretical model, self-efficacy is associated with health-promoting behaviors, however in the current study, no significant relationship was found. Previous researchers observed that perceived self-efficacy was an important predictor of health-promoting behaviors (Agazio & Buckley, 2010; Barnes & Lu, 2012). Barnes & Lu (2012) used a phenomenological approach to examine medication adherence among persons of Latino ethnicity and found that low levels of self-efficacy were associated with a lack of adherence in taking medications. Similarly, Agazio et al. (2010) examined health-promoting behaviors

among active duty military women with children and saw that self-efficacy was a significant predictor of physical activity (Agazio & Buckley, 2010).

Self –efficacy is important to consider when individuals attempt to change health behaviors, particularly when barriers to health-promoting activities are present. When self-efficacy levels are high, persons are not as affected, and perceive barriers as being less of a deterrent (Pender et al., 2011). In the current study, there was no significant relationship between barriers to action and self-efficacy, in contrast to previous research. Padden et al. (2013) conducted a cross sectional survey among active duty military women with children and assessed their physical activity. In contrast to the current study, researchers found that stress and number of children were barriers to health-promoting behaviors, and the presence of barriers hindered efforts to be physically active (Padden et al., 2013). It is not clear why no association was seen between self-efficacy and barriers to health-promoting behaviors in the current study. Padden et al. (2013) reported that the presence of interpersonal influences (as measured by social support) mediated the association between stress and self-efficacy and that stress no longer served as a barrier to physical activity. Padden et al. (2013) examined family members and friends as sources of social support, unlike in the current research, which examined social support from health care providers. Another possible explanation may be the self-efficacy instrument used in the current study. The modified version of the Diabetes Empowerment Scale was not tested previously in persons of Latino ethnicity, and further testing of the tool is needed.

In the adapted theoretical model, the primary sources of interpersonal influences were measured with two items; a pre-diabetes questionnaire designed for the study by the researcher, and one question as to the participant's family members who have T2DM. The pre-diabetes questionnaire consisted of three yes/no questions, which asked whether participants were

informed by their healthcare provider that they were: (a) overweight, (b) at risk for diabetes or (c) told they had pre-diabetes. In current study, there was no association between interpersonal influences and physical activity, contrasting with previous research (Barnes & Lu, 2012; Padden et al., 2013). Previously, researchers have used family members and friends as sources of interpersonal influences, and researchers observed a significant association between health-promoting behaviors and social support (Kohlbry & Nies, 2009; Padden et al., 2013). The impact of social support from health care providers on health-promoting behaviors is not well understood among persons of Latino ethnicity, however previous researcher suggested that health care providers significantly influenced health-promoting behavior (Wambach et al., 2016).

In the current study, 61% of the participants reported having family members with diagnosed T2DM. The most commonly reported family member being the mother (31%), followed by the father (18%), and this was consistent with the familial influence in T2DM risk (Kelly et al., 2007; Kommoju & Reddy, 2011). The third most common family member reported was the grandmother (15%), which has also previously been reported in the literature as being a family member who was influential in contributing to diminished insulin sensitivity (Kelly et al., 2007).

In the current study, there was no significant relationship between having a family member with T2DM and the participant's physical activity. Given that prior research suggests that there is a genetic as well as environmental factor that contributes to T2DM (Sandberg, Rodriguez, Howard, Quandt, & Arcury, 2015), it is not clear why an association was not observed among Latinos who have a family member with T2DM and physical activity. A possible explanation may be that participants do not associate having a family member with diabetes as increasing their personal risk of later developing diabetes (Gallivan et al., 2009).

The findings from the current study suggested that social support from healthcare providers (as measure of interpersonal influences) might not be important among Latinos at risk for diabetes. The findings were similar to those of Sutherland et al. (2012), in which researchers stratified Latino participants into three groups based on T2DM risk. Researchers grouped Latino participants by risk status: (a) those with no risk factors for T2DM, (b) those at high risk for T2DM and (c) those with T2DM. When the researchers compared the level of interpersonal influence among the three groups, they did not find any differences (Sutherland et al., 2012). The findings from the current study suggested that multiple forms of social support (family, friends, health care providers or environmental) may be needed to promote and sustain healthy behaviors among persons of Latino ethnicity at risk for T2DM.

The current research study examined whether there was a significant relationship between physical activity and social support, with the source of support originating exclusively from health care providers. To date, there are few studies that examined the relationship of interpersonal influences between health care providers and the health-promoting behaviors among Latinos. Previously, Wambach et al. (2016) conducted a qualitative study that examined the benefits and barriers which promoted breastfeeding among females of Latino ethnicity. Researchers found that health care providers (nurses) were important in engaging young mothers in health promotion, as measured by Latino mothers exclusively breastfeeding their infants (Wambach et al., 2016). It is not clear in the current study why social support was not associated with physical activity. One consideration when comparing the study by Wambach et al. (2016) was that the majority of the women were not employed, however in the current study almost 60% of the participants worked and a negative association was seen between employment status and physical activity.

Summary and Discussion of Findings

Research Question One

The first research question was: How do Latino adults engage in health-promoting behaviors related to physical activity?

The responses to the study questionnaires demonstrated that Latinos engaged in many health-promoting behaviors. The total median MET mins/wk. was 5430, which was similar to previous research using the IPAQ questionnaire with Latinos (Hu et al., 2015; Roman-Viñas et al., 2010; Wolin et al., 2007). Wolin et al (2007) saw the total mean physical activity in MET mins/wk. was 3300, however, participants were Latino females exclusively. Similarly, in Roman- Viñas et al. (2010), researchers administered an exercise questionnaire to Spanish participants, who were comparable in both age and education to participants in the current study, and found that participants engaged in a mean of 4979.8 MET mins/wk. of physical activity (Roman-Viñas et al., 2010).

In the current study, Latino males engaged in significantly more vigorous physical activity when compared to females, similar to previous research (Casper et al., 2013). Casper et al. (2013) carried out a cross sectional study among persons of Latino ethnicity regarding perceptions of physical activity and in the amount of public park usage by gender. Researchers reported significant differences among Latinos in both the amount of time spent at the park and in the type of preferred activities (Casper et al., 2013). In the current study differences in the physical activity domains were seen as well, similar to previous research (Hu et al., 2015). Hu et al. (2015) conducted a secondary analysis to examine differences in physical activity levels among persons with T2DM and their caregivers. Researchers observed higher levels of moderate physical activity, while the level of moderate physical activity in the current study was

low comparatively (3384 MET mins/wk. vs. 720 MET mins/wk.). In Roman- Viñas et al. (2010), researchers saw considerably higher amounts of moderate physical activity when compared to participants from the current study (1169 MET mins/wk. vs. 720 MET mins/wk.). This difference in the amount of moderate physical activity may be due to social desirability, or perceptions among participants that occupational activity was a type of moderate physical activity (Kohlbry & Nies, 2009).

There was a significant difference in participant age and level of activity in the current study. Participants between the ages of 18-42 performed higher amounts of both vigorous and moderate MET mins/wk. when compared to persons 43 and older. This finding was consistent with previous literature that examined physical activity levels among Latinos (Kohlbry & Nies, 2009; Plasencia, Hoerr, Carolan, & Weatherspoon, 2017). In the current study, older participants preferred walking to moderate physical activity, which was seen previously as a more culturally appropriate activity for many older Latinos (Plasencia et al., 2017).

The participants in the current study did not engage frequently in moderate physical activity, since moderate physical activity had the lowest number of MET mins/wk. In contrast with the current study, previous research demonstrated that Latinos had significantly higher levels of moderate physical activity when compared to non-Hispanic Whites and African Americans (Seo & Torabi, 2007). The study by Seo et al. (2007) was a cross sectional analysis where researchers examined whether gender, age, ethnicity or income influenced moderate and vigorous physical activity among U.S. adults. It is not clear why participants from the current study engaged in low amounts of moderate physical activity. One possible explanation for the difference in moderate activity may be due to perceptions in work-related activities among Latinos. Participants may perceive employment activity as more vigorous in nature, however,

the level of activity from work may not confer the same health benefits as vigorous physical activity (Plasencia et al., 2017).

In the current study, educational level was not associated with physical activity. The educational level among the participants in this study was low, similar to that in previous research among Latinos (Silveira et al., 2014; Sutherland et al., 2012). The current study did find a high number of participants with college degrees (18%), which was comparable to a previous study among persons of Latino ethnicity (Silveira et al., 2014). In the study by Silveira et al. (2014), researchers measured changes in level of perceived stress by pregnancy trimester among women of Latino ethnicity from a large, urban hospital center. In the current study, the high number of college educated Latinos was an unexpected finding. The number of college educated participants was a bit of a paradox, given that previous researchers found an association between educational level and socio-economic status (Pérez-Escamilla, 2011), yet the socio-economic status of the current study participants was low.

In the current study, employment status was significantly associated with physical activity, particularly in the amount of vigorous physical activity. Similar to a previous study, researchers found that employment status was a predictor of vigorous physical activity, but not in moderate physical activity (Seo & Torabi, 2007). This finding is confusing since Latinos reported previously that they faced multiple demands on them and that engaging in physical activity was not always feasible (Mikell et al., 2016). A possible explanation for the apparent contradiction may be since Latinos report limited time to exercise, they may perceive vigorous physical activity provides them with the same health benefits as moderate physical activity, but in a shorter amount of time.

Research Question Two

The second research question was what was the relationship between acculturation, self-efficacy, stress and the health-promoting behavior of physical activity among Latino adults?

Latinos with pre-diabetes/T2DM

We enrolled in the current study, 40 Latinos with pre-diabetes/T2DM, 32 females and 6 males and 2 who did not report their gender. Latinos with pre-diabetes/T2DM were significantly older with a mean age of 50.2 years (SD=11.76) when compared to Latinos without pre-diabetes/T2DM. Latinos with pre-diabetes/T2DM had levels of self-efficacy and stress similar to levels in Latinos without pre-diabetes/T2DM. Latinos with pre-diabetes/T2DM engaged in the following amounts of physical activity (median values): 1440 Vigorous MET mins/wk., 720 moderate MET mins/wk., 1188 walking MET mins/wk. and a total amount of 4022.2 MET mins/wk. (Table 4.3).

When comparing the current findings to previous research, participants with pre-diabetes/T2DM from the current study engaged in low levels of physical activity (Hu et al., 2015; McEwen et al., 2010). In the study by McEwen et al. (2010), researchers conducted an intervention to improve diabetes self-management among Latino participants diagnosed with T2DM. McEwen et al. (2010) saw that Latinos engaged in 2211 vigorous MET mins/wk., 1551 moderate MET mins/wk., and 2567 walking MET mins/wk., with the total amount of physical activity of 6329 MET mins/wk. (McEwen et al., 2010). Even the pre-intervention levels of physical activity among the Latino participants in the McEwen et al. (2010) study were higher when compared to the participants' levels in the current study. A possible explanation for the differences in physical activity between the McEwen et al. (2010) study and the current study may be due to the effects of acculturation. Previous researchers reported that as Latinos continue to acculturate to the U.S., they engage in higher amounts of physical activity (Ghaddar et al.,

2010; Pérez-Escamilla, 2011). As a comparison, McEwen et al. (2010) reported the average study participant lived in the U.S. for 40 years, however, in the current study, the participant's average length of time in the U.S. was 10 years or less.

The findings from the current study contrast with previous research conducted among persons of Latino ethnicity diagnosed with T2DM. Hu et al. (2015) performed an 8-week, educational intervention, with the goal being to improve T2DM outcomes by increasing the amount of walking behaviors among Latinos with T2DM and their caregivers. The pre-intervention levels of walking in the Hu et al. (2015) study were higher when compared to the level of walking in participants from the current study. Hu et al. (2015) reported the total amount of MET mins/wk. was 6113.7 for participants with T2DM and 6779.5 for their non-T2DM caregivers. In the current study, the total number of MET mins/wk. for Latinos with pre-diabetes/T2DM was approximately one-third lower. It is not clear why the level of physical activity was significantly lower in the participants from the current study, but it may be due to the study location. In the current study, Latino participants came from a mid-western, urban setting, whereas Hu et al. (2015) obtained their study sample from two rural clinics in North Carolina. It is possible that living in more rural areas allows for more walking activity, but it is also possible that the warmer study location may be more conducive to being outdoors for a greater part of the year.

In the current study, a modified version of the Diabetes Empowerment Scale (DES) was used to measure the construct of self-efficacy, however as mentioned previously, there was no association between self-efficacy and physical activity. The findings from the current study are mixed when compared to previous studies examining self-efficacy among Latinos with T2DM. Previous studies among Latinos with T2DM found significant associations between self-efficacy

and the outcome variables (Barnes & Lu, 2012; García, Brown, Horner, Zuñiga, & Arheart, 2015).

In the current study, the self-efficacy score among study participants with pre-diabetes/T2DM was consistent with previous research using the original DES instrument (Kamimura et al., 2014). In the study by Kamimura et al. (2014), researchers using the original DES instrument, measured self-efficacy among participants with T2DM and their family members in a cross sectional survey. Study participants were recruited from free clinics where they accessed health care services, resulting in an ethnically diverse sample, with over half of the participants being of Latino ethnicity. However, researchers found no association between self-efficacy and improved diabetic symptom management in study participants with T2DM, even after having attended a diabetes education intervention. Researchers found only two predictors of increased self-efficacy for diabetes, being born in the U.S. and being an English speaker (Kamimura et al., 2014). One possible explanation for a diminished effect of self-efficacy in the study by Kamimura et al. (2014) may be that participants with diabetes from the free clinic reported both a poorer overall health and higher levels of stress.

Stress was measured in the current study using the Perceived Stress Scale (PSS-14) (Cohen et al., 1983). The self-reported stress level among participants with pre-diabetes/T2DM was not associated with physical activity, in contrast to previous research among persons of Latino ethnicity (Gallagher-Thompson et al., 2006; Silveira et al., 2014). Gallagher-Thompson et al. (2006) used the PSS-14 to measure care-giver stress between Latino and non-Latino white caregivers. Latino care-givers reported higher baseline levels of stress when compared to non-Hispanic White care givers (34.45 vs. 31.07). However, the findings from Gallagher-Thompson et al. (2006) may not represent the perceived stress among Latinos with pre-diabetes/T2DM, as

they recruited non-diabetic participants. However, in the research by Silveira et al. (2014), the researchers examined the effects of stress on glucose intolerance among Latinas with gestational diabetes. The reported stress level of female Latinos was 26 (SD = 7) in early pregnancy and 25 (SD = 7.4) in mid-pregnancy, which was higher than reported stress in the participants from the current study (Silveira et al., 2014). Similar to the current study, Silveira et al. (2014) also found no association between levels of perceived stress and the dependent variable of glucose intolerance.

After comparing the mean scores from the participants with pre-diabetes/T2DM in the current study, the Latino participants with pre-diabetes/T2DM likely had average levels of perceived stress. The alpha level for the Perceived Stress Scale in this study was .690, which was lower compared to previous studies where the instrument was used (González-Ramírez et al., 2013; Hughes et al., 2008). It is not clear why the alpha level was lower in the current study. One possible explanation may be educational level of the participants. While 16% of the study participants had a college degree, 40 % of the participants reported having less than a high school education, similar to previous cross sectional studies among persons of Latino ethnicity (Sutherland et al., 2012; Wambach et al., 2016).

Latinos without pre-diabetes/T2DM

In the current study there were 148 Latinos without pre-diabetes/T2DM, 96 females and 40 males and 12 participants who did not report their gender. Latinos without pre-diabetes/T2DM had levels of self-efficacy and stress similar to those with pre-diabetes/T2DM. While the amount of physical activity was higher among Latinos without pre-diabetes/T2DM, there was no statistical difference in the levels of physical activity between Latinos without pre-diabetes/T2DM when compared to Latinos with pre-diabetes/T2DM (Table 4.3). Latinos

without pre-diabetes/T2DM engaged in the following amount of physical activity (median values): 1600 Vigorous MET mins/wk., 840 moderate MET mins/wk., 1108 walking MET mins/wk. and a total number of 4320 MET mins/wk. The findings from the current study contrast with another study that found that Latinos were engaging in high levels of moderate physical activity (Kohlbry & Nies, 2009). A possible explanation for the difference in physical activity level among Latinos without pre-diabetes/T2DM may be due to the age of the participants. As stated previously, in the current study Latinos without pre-diabetes/T2DM were significantly younger when compared to Latinos with pre-diabetes/T2DM ($p = .007$).

In the present study, there was no difference in levels of self-efficacy among Latinos without pre-diabetes/T2DM when compared to Latinos with pre-diabetes/T2DM. Self-efficacy, as mentioned earlier, was measured with the modified version of the Diabetes Empowerment Scale, a psychometric instrument that has not previously been tested among persons of Latino ethnicity. Contrasting with previous research, self-efficacy scores in the Latino participants without pre-diabetes/T2DM were found to be lower when compared to Australian and ethnic Chinese participants (Hackworth et al., 2007). A possible explanation for the difference in self-efficacy scores between the ethnic groups might be that both Australian and Chinese participants were significantly older and had already received a diagnosis of pre-diabetes (Hackworth et al., 2007). Another possible explanation is the Australian and Chinese participants in Hackworth et al. (2007) had higher levels of education than the participants in the current study, and possibly higher levels of health literacy.

In this study, there was no difference in levels of perceived stress among Latinos with pre-diabetes/T2DM when compared to Latinos without pre-diabetes/T2DM. Perceived stress in Latinos without pre-diabetes/T2DM from the current study was 22.93, which was similar to

previous research (González-Ramírez et al., 2013). In contrast to the current study, previous researchers found an association between perceived stress and diminished health-promoting activities among Latinos (Insaf et al., 2011). Insaf et al. (2011) conducted a prospective cohort study of the effects of stress on intentions to breastfeed among women of Latino ethnicity. In contrast to the current study, researchers found that Latino women who reported high levels of perceived stress were 24% less likely to breast feed, even after adjusting for confounders of age, educational status, place of birth or employment status (Insaf et al., 2011). A possible explanation for the different stress levels between Insaf et al. (2011) and the current study may be the due to the stress of pregnancy and the fact that 86% of the women were not married, and that absence of a consistent partner may be significant source of perceived stress.

It is not clear why Latinos without pre-diabetes/T2DM exhibited similar levels of stress, self-efficacy and physical activity when compared to Latinos with pre-diabetes/T2DM. Results from the current study suggest that levels self-efficacy and stress among Latinos both with and without pre-diabetes/T2DM were not associated with physical activity. Acculturation level may be one explanation, and will be examined in more detail in research question number 4.

Research Question Three

The third research question was what was the relationship between acculturation, self-efficacy, stress and the health-promoting behavior of physical activity among Latino adults?

In the current study, participants who engaged in walking were more likely to perform both vigorous and moderate physical activity. A positive association was found between vigorous physical activity and walking ($\chi^2(195) = .380$, $p = .05$) and in moderate physical activity and walking ($\chi^2(195) = .278$, $p = .001$). The findings from the current study are supported by two earlier studies where the investigators examined physical activity levels among

persons of Latino ethnicity (Casper et al., 2013; Hu et al., 2015). In Hu et al. (2015), Latinos who engaged in walking were more likely to increase their level of moderate physical activity similar to the current study. Similar to the current study, researchers also saw that when Latinos engaged in recreational activities (walking), they were more likely to engage in more vigorous physical activity (i.e. play sports) (Casper et al., 2013).

In the current study, there was no correlation between self-efficacy and physical activity. In the study by Hackworth et al. (2007), researchers found that the self-efficacy subscales of eating and exercise had acceptable alpha levels among their ethnically diverse study participants, similar to the current study. Also, as with the findings in this study, there was a significant correlation between self-efficacy subscales of eating and exercise (Table 4.5). In contrast to previous research, we found that dietary preferences and physical activity were associated with overall self-efficacy. In the study by Smith-Miller et al. (2016), researchers examined the health-promoting behaviors of Latinos with T2DM using both psychometric and physiological measurements. Researchers found that while participants of Latino ethnicity showed high levels of self-efficacy in controlling their T2DM, they were less confident in the ability to have healthy dietary preferences in certain social situations (Smith-Miller, Berry, DeWalt, & Miller, 2016).

In the current study, acculturation was measured with the Acculturation Rating Scale for Mexican-Americans-II (ARSMA-II). The mean MOS subscale score of the current study participants was 4.32 (SD = .74) and for the AOS subscale score was 2.64 (SD = 1.06) with the total ARSMA-II score of -1.68, similar to previous research among Latino participants with low acculturation levels (Campos et al., 2007; Plasencia et al., 2017; Wambach et al., 2016). In the current study, the alpha level for the ARSMA-II instrument was 0.67, which despite being low, was consistent with previous research (Plasencia et al., 2017).

The Latinos in the current study were recent immigrants to the U.S. as seen by 74% of participants being in the U.S. for less than 10 years. Despite the amount of time spent in the U.S., the majority of the sample maintained their Mexican orientation as suggested by the ARSMA-II scores. As Latinos became more acculturated to living in the U.S., previous researchers found that Latinos became more physically active which served as a protective health factor (Barrera Jr et al., 2012; Ghaddar et al., 2010).

Research is mixed as immigrants acculturate to life in the U.S., as level of physical activity does not always reflect amount of time spent in the U.S. As immigrants continue to live in the U.S., researchers have witnessed less physical activity among women of Latino ethnicity and subsequent increases in body mass index (a measure of obesity), which can later increase risk for developing T2DM (Kandula et al., 2008). Previous research among Latino females found that the current economic environment in the U.S. required them to work outside the home (Wambach et al., 2016). In the current study, over 50% of the participants worked full time, and demands of full time employment can impact attempts to exercise, particularly in Latino women with young children. The demands of work, caring for family members and managing the home can limit efforts to be physically active among Latino females (Mikell et al., 2016).

In the current study, perceived stress was negatively associated with the total amount of physical activity, ($\chi^2(195) = -.170$, $p = .05$) consistent with findings from previous research (Insaf et al., 2011; Padden et al., 2013). Latinos frequently reported perceived stress during the acculturation process due to difficulty finding jobs, isolation, and discrimination which impacted health promotion efforts (Insaf et al., 2011). In the current study, there was also a significant relationship between perceived stress and self-efficacy to exercise subscale. Padden et al. (2013)

also found that active duty military spouses reported an inability to engage in health-promoting behaviors due to the stress of caring for children and a lack of social support.

Research Question Four

The fourth research question asked what was the relationship between acculturation, self-efficacy, stress and the health-promoting behavior of physical activity amongst Latino adults with pre-diabetes/T2DM and Latino adults without pre-diabetes/T2DM?

To analyze question number 4, hierarchical multiple regression was used. After adjusting for age and gender, the contributions of the independent variables acculturation, self-efficacy, stress and diabetes status were evaluated for the percent of variance explained in physical activity. Further analysis was completed in stratifying the sample by participants with pre-diabetes/T2DM versus participants without, and hierarchical regression was then performed to compare the effect of diabetes status on physical activity.

In the current study, participants of Latino ethnicity who reported engaging in physical activity did not differ on the independent variables when compared to those who did not (Table 4.6). The absence of significant differences between the two groups based on disease status was similar to previous research among persons of Latino ethnicity (Chilton et al., 2006; Sutherland et al., 2012). Sutherland et al. (2012) conducted a cross sectional analysis among persons of Latino ethnicity and divided the study participants in to T2DM risk groups. Here too, researchers did not observe any differences among Latino participants in dietary preferences, levels of physical activity or in taking responsibility for their health based on T2DM risk status (Sutherland et al., 2012). The self-efficacy subscale for exercise (SE-Exercise) predicted physical activity when the data were entered into the regression model, however, when stress was added, the variable SE-Exercise was no longer significant (Table 4.7). Similar to the

previous research, the participants in the current study had limited confidence in their ability to exercise, particularly under stressful situations (Smith-Miller et al., 2016).

In this research study, both age and gender significantly contributed to the regression models (tables 4.8 & 4.9), which was seen previously (Casper et al., 2013; Geiss et al., 2010). Here too, study participants with T2DM were significantly older than participants without (Kamimura et al., 2014; Smith-Miller et al., 2016). Gender differences were previously seen in persons with Latino ethnicity, with Latino women engaging in lower amounts of physical activity, consistent with the current study findings (Benitez, Dodgson, Coe, & Keller, 2015; Casper et al., 2013). Women of Latino ethnicity frequently reported barriers such as family roles, care-giving responsibilities for family members and working outside the home as barriers to physical activity (Kohlbry & Nies, 2009; Mikell et al., 2016).

As seen previously by researchers, self-efficacy subscales for eating and exercise predicted physical activity (Smith-Miller et al., 2016). Stress was negatively associated with physical activity, which was consistent with previous research (Padden et al., 2013). Previous researchers also found a negative association between stress and health-promoting behaviors, which may explain why SE-Exercise became non-significant when the variable of stress was added to the model (Table 4.7) (Flores et al., 2008; Padden et al., 2013).

When pre-diabetes/T2DM status was entered into the regression model, gender remained a consistent predictor of physical activity. The effect of gender on physical activity may be due to the large percentage of females in the current study when compared to the number of males, particularly in Latinos with pre-diabetes/T2DM (Benitez et al., 2015; Seo & Torabi, 2007). The self-efficacy subscale for exercise significantly predicted physical activity, however when stress was entered into the model, the self-efficacy subscale for exercise was no longer significant

(Table 4.9). The effect of stress on the self-efficacy exercise subscale scores may be explained by some of the stressful social environments where the participants live. When confronting issues of poverty, disparities in health outcomes and discrimination, minority groups become more susceptible to the effects of stress (Flores et al., 2008; Gallo et al., 2011). In the current study, no association was found between socio-economic status and physical activity, thus it is possible that other factors might be affecting physical activity which were not considered as a part of the current study.

Latinos with pre-diabetes/T2DM

Among the participants with pre-diabetes/T2DM, age was the only significant predictor of physical activity (Table 4.11) consistent with previous research (Kamimura et al., 2014). None of the study variables of gender, acculturation, the self-efficacy to eat subscale, the self-efficacy to exercise subscale or stress was a predictor of physical activity, which contrasted with previous research (Barrera Jr et al., 2012; Hu et al., 2015). Previously, Latinos with known T2DM reported barriers to physical activity, such as physical pain, obesity and lack of motivation, which might explain why age was the only predictor of physical activity among Latinos with pre-diabetes/T2DM (Hu et al., 2015; Smith-Miller et al., 2016).

In the current study, stress was not a significant predictor of physical activity among Latinos with pre-diabetes/T2DM, which contrasted with previous research. In previous research, stress was found to be associated with lower levels of physical activity and also was negatively associated with self-efficacy (McEwen et al., 2010; Padden et al., 2013). In McEwen et al (2010), researchers found that culturally tailored interventions among Latinos with T2DM improved T2DM self-management, but did not influence physical activity. The findings from this study suggest that participant's perceived stress was not different from previous research

(González-Ramírez et al., 2013), and is also supported by the lack of association between socio-economic status and physical activity in the current study.

The current study found that acculturation was not a significant predictor among participants with pre-diabetes/T2DM, which was consistent with previous research (Ghaddar et al., 2010). Ghaddar et al. (2010) found that among Latinos with low levels of acculturation (more Mexican orientation), lower amounts of physical activity were observed. Mexican acculturation can also serve as a protective factor, as Mexican acculturation was associated with a healthier diet (Ghaddar et al., 2010; Pérez-Escamilla, 2011). Dietary preferences were not included as a part of the current study, and future studies should be conducted among Latinos with pre-diabetes/T2DM and measure the effect of acculturation on dietary preferences.

In the present study, the participants were stratified by diabetes status in order to more closely examine differences in the independent variables by pre-diabetes/T2DM status. Stratification is a statistical method that removes the variance on the matching variable (diabetes status) and produces a more powerful statistical test (Shadish, Cook, & Campbell, 2002). In the stratified sample, the regression models demonstrated that moderate and walking physical activity were not significant predictors of physical activity among persons with pre-diabetes/T2DM. In the regression models for total physical activity and vigorous physical activity in Latinos with pre-diabetes/T2DM, only gender predicted physical activity (Tables 4.14 and 4.15).

Latinos without pre-diabetes/T2DM

When examining the physical activity of participants without pre-diabetes/T2DM, only the regression models of vigorous physical activity and total physical activity were significant in the current study. In the domain of total physical activity, self-efficacy was the only significant

predictor of physical activity (Table 4.12) consistent with the study by Smith-Miller et al. (2016). In the domain of vigorous physical activity, both gender and self-efficacy were significant predictors (Table 4.13), which was also consistent with previous research (Casper et al., 2013).

Gender was a significant predictor of vigorous physical activity, but not in the domain of total physical activity, which is supported in the literature (Casper et al., 2013; Kohlbry & Nies, 2009). In the current study, males participated in higher amounts of vigorous physical activity compared to females, similar to the study by Casper et al. (2013), where males of Latino ethnicity preferred engaging in sports and females preferred walking with their children. Previous research with Latino females demonstrated that females were more likely to engage in vigorous activities such as salsa dancing or exercise classes in Spanish (Kohlbry & Nies, 2009). Researchers reported that overall levels of physical activity among Latino females remained low, which was consistent with the current study (Neighbors, Marquez, & Marcus, 2008).

In the current study, self-efficacy was a significant predictor of both total physical activity and vigorous physical activity among Latinos without pre-diabetes/T2DM, which supports the theoretical model (Pender et al., 2011). When both the self-efficacy subscales of Eating and Exercise were separately examined among Latinos, previous researchers found correlations between the SE-Exercise subscale, but not in the SE-Eating subscale (Smith-Miller et al., 2016). In contrast to the study findings, both self-efficacy subscales predicted physical activity in Latinos without pre-diabetes/T2DM. A possible explanation for the mixed findings in the self-efficacy subscales may be related to the lower acculturation scores found in the current study. Previous researchers found that lower acculturated persons of Latino ethnicity have healthier dietary preferences, but less physical activity (Ghaddar et al., 2010; Pérez-Escamilla,

2011). Further research is needed to examine how self-efficacy can influence Latinos without pre-diabetes/T2DM, particularly their confidence to eat healthy.

Implications

This research study expands our understanding of how acculturation, self-efficacy and stress influence health-promoting behaviors. The findings from the current study will be discussed in the following sections as they apply to future research, public policy and nursing practice. The findings from the adapted theoretical model will also be discussed and compared to previous research that used adapted theoretical models. Study strengths will also be discussed.

Future Research

Future research among Latinos without pre-diabetes/T2DM, specifically with physical activity as the outcome behavior, would strengthen the existing knowledge base and possibly lower risk of T2DM development. Future studies with Latino participants in diabetes prevention programs (DPP) are viable options, as diabetes prevention programs were seen as previously effective at lowering risk of future T2DM development (Knowler et al., 1995). However, follow up visits in previous DPPs among Latinos varied from several weeks, to a year, which may not be enough time to sustain changes in health-promoting behaviors (Barrera Jr et al., 2012; Vincent, 2009; Delia S West et al., 2008). Longitudinal research in the context of a DPP with teaching sessions taking place at multiple sites, such as health care systems, clinics and community centers will enable researchers to examine physical activity and dietary preferences several time points.

There were also gender differences in Latino participants, with males preferring vigorous activity and females preferring to walk, consistent with the previous research by Casper et al. (2013). It is possible that women of Latino ethnicity encounter additional barriers to physical

activity, such as physical disability or obesity, which were not measured in the current study. Child and family obligations were also cited as frequent barriers to physical activity (Castro-Rivas et al., 2014; Mikell et al., 2016), and future interventions to ameliorate gender differences in physical activity may need to include different forms of social support.

In previous research that measured physical activity in Latinos, researchers found that persons of Latino ethnicity had broad perspectives on what constituted physical activity (Mier et al., 2007; Seo & Torabi, 2007). Levels of moderate physical activity were much lower among the current participants when compared to other studies, and previous research suggested that cultural differences may exist among Latinos as to what constitutes moderate physical activity (Hu et al., 2015). Future research among Latinos may require the use of several approaches to measure physical activity, such as accelerometers or walking counters in addition to self-reported questionnaires. Additionally, culturally appropriate measurement tools are needed, particularly when working with persons of Latino ethnicity with low levels of acculturation. In the I-PAQ questionnaire, examples of vigorous physical activity include heavy lifting and fast bicycling and examples of moderate physical activity include bicycling or playing doubles tennis, which may not reflect the cultural activity preferences of persons with Latino ethnicity.

In this study, there was no association between social support and physical activity. Previous research suggested that social support was very important to Latinos (McEwen et al., 2010; Mikell et al., 2016), and social support networks were important in any programs designed to increase physical activity and improve dietary preferences (Plasencia et al., 2017). Neither social support from the health care provider nor from the family member was associated with physical activity in the current study. Future research needs to examine the relationship between health care providers and Latinos, since Latinos regard trust in healthcare providers as important

(Barnes & Lu, 2012). In future research, dietary preferences need to be included, as Latino cultural foods are important to them and need to be considered in health-promoting activities (Caballero, 2007; Pérez-Escamilla, 2011). Interventions need to record dietary intake so participants will become more aware of what they are eating and how much.

Policy

Increased collaboration between larger health systems and the community health centers will enhance access to specialty care, which is vital to the management of chronic illnesses, such as T2DM. Community Health Centers, along with Nurse Managed Health Clinics (NMHC), are charged with providing health care services to vulnerable populations and require continued financial support. Many of the funds for the Nurse Health Clinics comes from grants and university contributions, whereas, community clinics are funded through the Health Resources & Services Administration Bureau of Primary Health Care and the Medicare/Medicaid prospective payment funding (Pohl, Tanner, Pilon, & Benkert, 2011).

Nurse Managed Centers require continued financial support to provide access to healthcare services in the communities that they serve. Recently the Department of Health and Human Services announced over 50 million in funding to expand services at 75 health centers (U.S. Department of Health and Human Services, 2016). The department of Health Resources and Services Administration is also increasing the number of providers in healthcare shortage areas and expanding the capacity of clinics to offer more services to at-risk populations (U.S. Department of Health and Human Services, 2015). The funding helps to meet the needs of vulnerable populations, yet more needs to be done to insure a seamless communication between large health systems and community clinics if reducing disparities in health outcomes and improved quality of care is the objective.

Partnerships between large health systems and community clinics/cultural centers can foster a trusting relationship, which is important to persons of Latino ethnicity. In the current study, there was no significant relationship between social support and physical activity, which was consistent with previous research (Wambach et al., 2016). Despite the lack of association in social support, participants in the current study reported receiving the message about T2DM risk from their healthcare providers. In this study, 56% of the participants were informed by a healthcare provider of their T2DM risk factors. T2DM risk factors were further supported by examination of the responses to the pre-diabetes questionnaire. Significant associations were found between the being told about diabetes risk, as well as being informed they were overweight. It is not clear why the participants still remain relatively sedentary, despite receiving information about their own T2DM risk. It is conceivable that Latinos perceive the potential threat of T2DM differently, so communicating disease risk frequently is needed. Policy efforts towards persons of Latino ethnicity need to use multiple approaches such as, newspapers, television, radio social media and social/community gatherings.

Another possible venue to increase physical activity in persons of Latino ethnicity might be places of employment. Over 60% of the study participants were employed and work site wellness programs may present another opportunity to increase physical activity. Employers can create a culture of physical activity by creating space for stationary bicycles, offering aerobic classes, and providing locker rooms and/or showers. Employers can create flexible schedules for employees who either ride bicycles to work, and provide a safe place to store bicycles and clothing.

The current study findings inform healthcare systems and policy in several important ways. Reducing disparities in the health outcomes for the people in Wisconsin are one of the

focus areas as outlined in the Healthiest Wisconsin 2020 report. Some of the objectives listed in Healthiest Wisconsin 2020 are to increase physical activity at the school and community level through the increased use of community open spaces such as parks and recreation centers, increased funding for chronic disease prevention, increased access to culturally competent chronic disease management and to decrease disparities in chronic diseases based on race, ethnicity and socio-economic status (Wisconsin Department of Health Services, 2010). Increased access to culturally competent health care services are essential if the goals of Healthiest Wisconsin 2020 are to be achieved. Despite the increase in access to health care services due to the Affordable Care Act, however, 35.2% of Latinos continued to encounter barriers to accessing healthcare services when compared to 26.5% of the total population (Agency for Healthcare Research and Quality, 2014).

Practice

The current study has ramifications for nursing practice because persons of Latino ethnicity continue to engage in low levels of physical activity, regardless of pre-diabetes/T2DM status. Nurses and other healthcare providers need to be aware of the cultural dimensions of health and need to use culturally competent approaches when working among persons of Latino ethnicity with low levels of acculturation. Culturally competent health care means that nurses and other health care professionals understand the values and practices of Latinos, as well as enter into patient interactions under the premise of mutual respect. Previous researchers demonstrated that persons of Latino ethnicity engage in health-promoting behaviors, however culturally competent approaches are needed to sustain health-promoting activities (Amirehsani, 2010; Lujan, Ostwald, & Ortiz, 2007). Culturally competent communication involves

interventions that are offered in Spanish by bilingual health care providers, inclusion of family members and having group activities at community health centers (Amirehsani, 2010).

Another way to provide culturally competent care is the use of a promotora or Community Healthcare Worker (CHW). Community Healthcare Workers or promotoras are members from the Latino community who received additional health training and also possess an emic perspective of the health beliefs and practices of the Latino community (Amirehsani, 2010; McEwen et al., 2010; Vincent, 2009). Promotoras build diabetes expertise among Latinos by sharing knowledge regarding appropriate food items, the role of medications and herbs, feasible physical activities and culturally specific health beliefs (Clingerman & Brown, 2012; Lujan et al., 2007). If nurses cannot communicate with the patient in their native language, or are unsure of the patient's command of English, then use of a promotora is essential.

Continuing education for current health care providers should include educational opportunities, guest presentations, and structured interactions between persons of Latino ethnicity, either via social networks (i.e. internet based) or face-to-face. Spanish speaking opportunities for health care providers build confidence when providing health care services to persons of Latino ethnicity (Amirehsani, 2010). Determining the appropriate teaching materials and which instructional approach to use improves adherence to plans of care and may increase the patient's perception of the quality of care they received (Becerra et al., 2015).

The majority of the participants in the current study reported low levels of education, so it is important for nurses to assess educational level a potential marker of health literacy. Health literacy refers to an individual's ability to read, understand and utilize health related information to make decisions and follow treatment recommendations (Campos, 2007). Persons with low levels of health literacy may have difficulty in processing health information (Amirehsani, 2010).

Latinos with low levels of health literacy frequently report challenges in managing complex chronic illnesses, such as glycemic control and medication management (Vincent, 2009). When nurses recognize low health literacy and adjust the teaching approach accordingly, communication and mutual understanding can take place.

The findings from the current study suggest that older Latinos participate in lower levels of physical activity when compared to younger Latinos, yet age and gender are significant predictors of developing T2DM (Casper et al., 2013; Davidson & Schriger, 2010). When nurses are working with older Latinos, the client must be assessed for physical activity. The assessment can be simply done with one question, "Do you walk for leisure every day for at least 30 minutes?" Assessing walking behaviors is important, because in this study, walking was associated with both moderate and vigorous physical activity. If older persons of Latino ethnicity are not walking, the nurse needs to investigate further as to a possible physical or environment barrier that may be limiting walking activities.

According to Social Cognitive Theory, an individual's level of self-efficacy determines the amount of effort people will use, and how long they will persist in a given activity despite facing barriers (Bandura, 1982). Self-efficacy was associated previously with health-promoting behaviors, such as healthy dietary choices, physical activity, and medication adherence, unlike in the current study (Barnes & Lu, 2012; Horwath, Nigg, Motl, Wong, & Dishman, 2010; Lovell, El Ansari, & Parker, 2010). In this study, self-efficacy was not associated with barriers to action, or with physical activity, yet the regression analysis demonstrated self-efficacy significantly predicted physical activity. Culturally competent nursing interventions designed to increase self-efficacy are likely to increase the outcome behavior, but follow-up contact via telephone or in-

person is vital to sustain the relationship and foster a sense of trust between the healthcare provider and persons of Latino ethnicity.

Adapting to a new life in the U.S. can be a stressful experience as new immigrants adapt to new customs and a new language. Still some immigrants suffer from additional stress due to having limited resources to care for themselves and their families (Rosal et al., 2011). The cumulative stress from the rapid cultural, economic and environmental changes can have adverse physiological effects such as elevated blood pressure and cortisol levels, which can increase the risk of T2DM (Gallo et al., 2011). In the current study stress was nearly associated with physical activity (p = .06), so while not statistically significant, nurses still need to consider stress levels in Latino patients. Nurses need to assess if patients feel upset or anxious regarding the cultural changes in their lives and provide techniques to manage stress successfully.

The current research study demonstrated that the adapted theoretical model was both feasible and valid. The adapted theoretical model provided a meaningful conceptual framework from which to examine health-promoting behaviors among Latinos both with and without pre-diabetes/T2DM. The current study did not find any significant associations between personal factors or the behavioral-specific cognitive factors with the outcome behavior, physical activity. It is not clear why significant associations were not found. In future use of the adapted model, there are other constructs that deserve mention and should be included: Commitment to a plan of action and immediate competing demands. Commitment to a plan of action is the start of the health-promoting behavior, as it involves intention to perform the behavior and at a specific time and place (Pender et al., 2011). Immediate competing demands, however, can sabotage attempts at committing to a plan of action and stop attempts at health-promoting behaviors (Pender et al., 2011).

Previously adapted versions of Pender's model were seen as valid frameworks in evaluating interactions in health-promoting activities. In the research by Padden et al. (2013), a modified model was used, as researchers examined physical activity among women veterans and included body mass index as a personal factor. In Eshah et al. (2010), Pender's Health Promotion Model was modified, with the theory constructs of prior related behaviors, commitment to a plan of action and competing demands being omitted. The modified model by Yang et al. (2007) closely resembled the modified model used in this study, and researchers found no significant relationships between either acculturation or age and levels of physical activity. One important difference between the current research study and that of Yang et al. (2007) was the outcome variable, only leisure time physical activity was investigated. In the current study, domains of vigorous and moderate physical activity were investigated in addition to leisure time activities such as walking.

The Latino population in the U.S. continues to grow so it will become increasingly important for nurses to become culturally competent health care providers (Amirehsani, 2010). Courses on cultural competency are important for nurses, particularly if the goal is to improve patient teaching and reducing disparities among health outcomes among persons of Latino ethnicity (Ho et al., 2010). One way to build confidence among nurses during interactions with persons of Latino ethnicity is to increase clinical opportunities, such as immersion in pre-dominantly Latino community clinics and social media interactions. Also, increasing the number of bilingual health care providers creates trusting relationships between the patient and the health care provider, and a trusting relationship is important among persons of Latino ethnicity (Martyn-Nemeth et al., 2010).

Study Strengths

There are limitations to generalizing the findings from the current study. The participants from this study were recruited from urban Latino cultural centers and predominately Latino parishes, which may not represent Latinos living in other areas in the U.S. The current political environment is uncertain not just for Latinos, but for many minority populations and fear of discovery may have influenced intention to participate in the current study. Despite the current political environment, 195 persons of Latino ethnicity participated. Furthermore, the study participants were also low acculturated and had lived in the U.S. for 10 years or less.

There were many more females in the current study than males, so interpretation of the study findings as they apply to gender differences, may not fully describe differences in physical activity among males of Latino ethnicity. Due to the cross-sectional nature of the current study, causality claims cannot be made. However, cross sectional studies are important to carry out, as they are economical to complete and serve as a background from which to launch an intervention study.

Despite the acceptable reliability level in the tested self-efficacy instrument, further refinement of the tool may be needed. There are few previous studies that used a modified version of the DES among persons with T2DM, so comparing self-efficacy scores between the original DES and the modified versions of the DES are not practical (Hackworth et al., 2007; Moore et al., 2011). The original Diabetes Empowerment Scale was designed to measure self-efficacy in person with T2DM, and the modified version of the DES was designed for use in persons at risk for T2DM development. Further testing with the modified version of the DES with larger sample sizes is needed to support the content and construct validity of the modified DES instrument.

Summary

The purpose of this cross-sectional, correlational study was to explore acculturation, self-efficacy and stress and how it influences health-promoting behaviors/physical activity among Latinos with and without pre-diabetes/T2DM. A secondary aim was to identify differences in health-promoting behaviors of Latino adults with pre-diabetes/T2DM and those without pre-diabetes/T2DM. English literacy, as well as health literacy, needs to be considered by health care providers when interacting with Latinos with low levels of acculturation. Also, it is important to offer continued support for bilingual and bicultural healthcare providers, as this may build a relationship based on trust among Latinos. Study findings are important to nursing education, practice, and policy in order to reduce disparities in health outcomes and increase access to healthcare services for Latinos.

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Appendix A

The Brief Acculturation Rating Scale for Mexican –Americans (ARSMA-II)

	Not at All/ *Nada*	Very Little/ *Un Poquito o a Veces*	Moderately/ *Moderado*	Very Often/ *Mucho o Muy Frequente*	Almost Always/ *Muchismo, Casi todo el Tiempo*
I speak Spanish. *Yo hablo Español.*					
I speak English. *Yo hablo Inglés.*					
I enjoy speaking Spanish. *Me gusta hablar Español.*					
I associate with Anglos. *Me asocio con Anglos.*					
I enjoy English language movies. *Me gusta ver peliculas en Inglés.*					
I enjoy Spanish language TV. *Me gusta ver programas en la television que sean en Español.*					
I enjoy Spanish language movies. *Me gusta ver peliculas en Español.*					
I enjoy reading books in Spanish. *Me gusta leer en Español.*					
I write letters in English. *Escribo (como cartas) en Inglés.*					
My thinking is done in the English language. *Mis pensamientos ocurren en el idioma Inglés.*					
My thinking is done in the Spanish language. *Mis pensamientos ocurren en el idioma Español.*					
My friends are of Anglo origin. *Mis amigos son Anglo Americano.*					

Appendix B

Diabetes Empowerment Scale-Modified Version

Please read each of the following statements and circle HOW CONFIDENT YOU ARE that you will exercise regularly, even if ...

		Not at all confident		Possibly		Very Confident
a)	you are feeling a bit tired	1	2	3	4	5
b)	you are very busy	1	2	3	4	5
c)	you don't feel physically up to it	1	2	3	4	5
d)	there are other things you want to do that are more fun	1	2	3	4	5
e)	you don't feel mentally up to it	1	2	3	4	5
f)	you have to do it on your own	1	2	3	4	5
g)	you don't enjoy it	1	2	3	4	5

Please read each of the following statements and circle HOW CONFIDENT YOU ARE that you will eat a healthy diet, even if ...

		Not at all confident		Possibly		Very Confident
a)	you feel upset	1	2	3	4	5
b)	you feel tense	1	2	3	4	5
c)	you are bored	1	2	3	4	5
d)	you are celebrating	1	2	3	4	5
e)	you are at a restaurant	1	2	3	4	5
f)	you are sad	1	2	3	4	5
g)	you are at home watching T.V.	1	2	3	4	5
h)	you are craving junk food	1	2	3	4	5
i)	you are at a party	1	2	3	4	5
j)	you are hungry	1	2	3	4	5
k)	there are others around you who are tempting you with junk food	1	2	3	4	5

Appendix C

Perceived Stress Scale (PSS-14)

The questions in this scale ask you about your feelings and thoughts during THE LAST MONTH. In each case, you will be asked to indicate your response by filling in the circle representing HOW OFTEN you felt or thought a certain way. Although some of the questions are similar, there are differences between them and you should **treat each one as a separate** question. The best approach is to answer fairly quickly. That is, don't try to count up the number of times you felt a particular way, but rather indicate the alternative that seems like a reasonable estimate.					
1.) In the last month, how often have you been upset because of something that happened unexpectedly?					
	0=Never	1=almost never	2=sometimes	3=fairly often	4=very often
2.) In the last month, how often have you felt that you were unable to control the important things in your life					
	0=Never	1=almost never	2=sometimes	3=fairly often	4=very often
3.) In the last month, how often have you felt nervous and "stressed"?					
	0=Never	1=almost never	2=sometimes	3=fairly often	4=very often
4.) In the last month, how often have you dealt successfully with day to day problems and annoyances?					
	0=Never	1=almost never	2=sometimes	3=fairly often	4=very often
5.) In the last month, how often have you felt that you were effectively coping with important changes that were occurring in your life?					
	0=Never	1=almost never	2=sometimes	3=fairly often	4=very often
6.) In the last month, how often have you felt confident about your ability to handle your personal problems?					
	0=Never	1=almost never	2=sometimes	3=fairly often	4=very often
7.) In the last month, how often have you felt that things were going your way?					
	0=Never	1=almost never	2=sometimes	3=fairly often	4=very often
8.) In the last month, how often have you found that you could not cope with all the things that you had to do?					
	0=Never	1=almost never	2=sometimes	3=fairly often	4=very often
9.) In the last month, how often have you been able to control irritations in your life?					
	0=Never	1=almost never	2=sometimes	3=fairly often	4=very often
10.) In the last month, how often have you felt that you were on top of things?					
	0=Never	1=almost	2=sometimes	3=fairly often	4=very often

		never			
11.) In the last month, how often have you been angered because of things that happened that were outside of your control?					
	0=Never	1=almost never	2=sometimes	3=fairly often	4=very often
12.) In the last month, how often have you found yourself thinking about things that you have to accomplish?					
	0=Never	1=almost never	2=sometimes	3=fairly often	4=very often
13.) In the last month, how often have you been able to control the way you spend your time?					
	0=Never	1=almost never	2=sometimes	3=fairly often	4=very often
14.) In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?					
	0=Never	1=almost never	2=sometimes	3=fairly often	4=very often

Appendix D

International Physical Activity Questionnaire (I-PAQ)

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **<u>last 7 days</u>.** Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1.) During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics or fast bicycling?

	Days per week		No vigorous physical activities	*If no vigorous activities, then skip to question 3*

2.) How much time did you usually spend doing **vigorous** physical activities on one of those days?

	Hours per day
	Minutes per day
	Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3.) During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? *Do not include walking.*

	Days per week		No moderate physical activities	*If no moderate activities, then skip to question 5.*

4.) How much time did you usually spend doing moderate physical activities on one of those days?

	Hours per day
	Minutes per day
	Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.
5.) During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

	Days per week		No walking	*If no moderate activities, then skip to question 7.*

6.) How much time did you usually spend **walking** on one of those days?

	Hours per day	
	Minutes per day	
	Don't know/Not sure	

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.
7.) During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

	Hours per day	
	Minutes per day	
	Don't know/Not sure	

Appendix E

Demographic Questionnaire

Participant Code number: ___________________ Date of birth: ___________________

Gender: Male_________ Female_________

Employment: Full-time___________ Part-time: __________ Unemployed: _________

Education: Elementary School (Grade) ______ Jr. High ______ High School ______ College ______

Approximate annual income:
$10,000-20,000/yr. _______________ $20,001-30,000/yr. _______________
$30,001-40,000/yr. _______________ $40,001-50,000/yr. _______________
$50,001 or more/yr. _______________

Place of birth (in U.S.): ________ Outside of US: _______ Country: ____________

How long have you lived in the U. S.?

Less than 10 years _________ More than 10 years _________

What is your ethnicity?
___Latino ___Non-Hispanic White ___African American ____Asian ___Other

Have you ever been told by a doctor that you have diabetes?

___Yes ___No

Have any of your family members been told they have diabetes?

Mother ____ Father____ Brother ____ Sister ____Grandmother ____ Grandfather ____

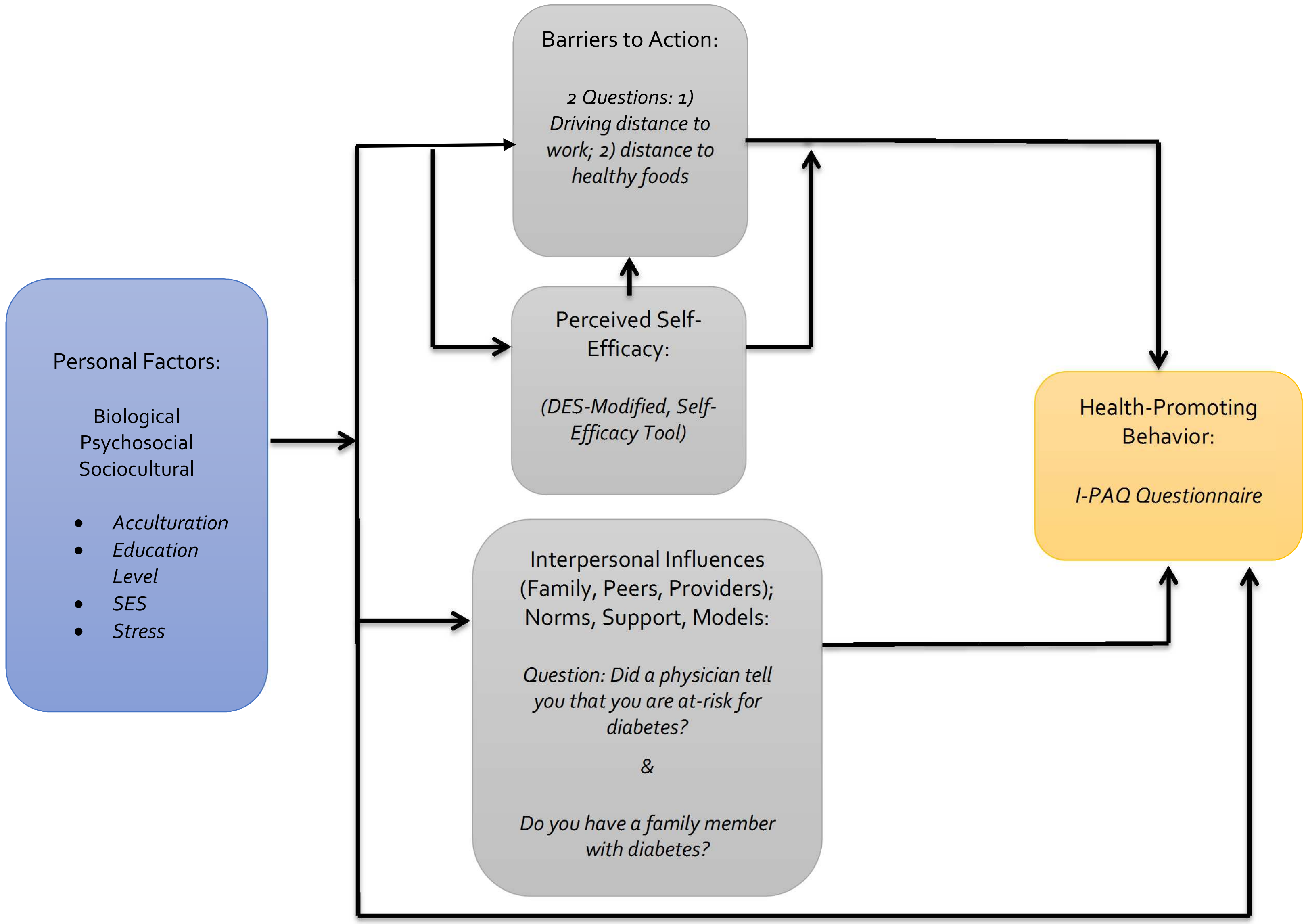
How long does it take you to get to work? Less than 30 minutes___ More than 30 minutes____ More than 60 minutes______

How far do you live from a store that sells fresh fruits and vegetables?
Less than 1 mile ________ Less than 5 miles ________ Less than 10 miles _______

Do you smoke? _______ No ________ Yes ______ Former Smoker
Please read each of the following statements and place an **X** by the statement that best describes what pre-diabetes means to you. **Please select 1 response only**:

My healthcare provider told me I have pre-diabetes _________.
My healthcare provider told me I am over-weight ___________.
My healthcare provided told me I am at risk for diabetes ___________.

Figure 1 Adapted Theoretical Framework (Appendix F)



Adapted from the Health Promotion Model by Pender by the researcher, Martin Mikell on October 2016

Appendix G

Re: Question from a doctoral student at the University of

Wisconsin-□Milwaukee College of Nursing_DES-□SF

Hi Martin,

You are welcome to download <www.med.umich.edu/mdrtc> and use, translate or revise any or all of our diabetes questionnaires. As long as you acknowledge the source in any articles or reports emanating from their use. The directions for scoring the instruments and the references describing the psychometric properties of the questionnaires can also be found on our web site. The short article describing the psychometric properties of the DES-□SF can be found on the website itself.

Please feel free to contact me if you have have further questions.

Take care. Bob Anderson

Robert Anderson Ed.D.

Professor Emeritis

University of Michigan

Medical School

boba@med.umich.edu

On Jan 29, 2014, at 12:02 PM, Martin Joseph Mikell <mjmikell@uwm.edu>

wrote:

Dr. Anderson:

My name is Martin Mikell and I am in my fourth year as doctoral student at the College of Nursing at UWM. I am attending school part time, and I also work as a staff nurse at the Clement

J. Zablocki Medical Center in the emergency department. In addition to these positions, I frequently work in the Latino community as an out-reach nurse, and between my two roles, I have seen the damage that poorly controlled diabetes can cause. Some of my areas of interest are diabetes, especially pre-diabetes, self-efficacy and Latino populations. I came across your measurement tool, the Diabetes Empowerment Scale, short form, during one of my courses, and found it very interesting, and well supported in the literature. I was interested in using this tool in the future, and that is the reason for my contacting you. As I mentioned earlier, I am interested in pre-diabetes among Latinos, and this is not a area that is well researched in the literature. Specifically, I am interested in examining self-efficacy in Latinos with pre-diabetes, and was curious if you would allow me to use your tool, the Diabetes Empowerment Scale, short form as a part of my research. I would like to do a pilot study using your tool

Anderson, Bob <boba@med.umich.edu>

Wed 1/29/2014 11:19 AM

To: Martin Joseph Mikell <mjmikell@uwm.edu>;

Re: Question from a doctoral student at the Universi... - Martin Jose...

https://outlook.office.com/owa/#viewmodel=ReadMessageItem&It...

1 of 2 10/22/15, 11:02 AM

(translated into Spanish) for use with persons with pre-diabetes from a community clinic in Milwaukee.

I am not quite ready to begin my study, as I will be preparing for my comprehensive examinations in the Spring. I have not yet written my proposal, so a lot can still happen. I wanted to contact you early in the process, so if this idea is not agreeable to you, then I can continue

searching the literature. If something I wrote is not too clear to you, please contact me. I appreciate your attention to this, and I look forward to hearing from you.

Sincerely,

Martin Mikell, BSN, RN

Doctoral Student

UWM-□CON

****

Electronic Mail is not secure, may not be read every day, and should not be used for urgent or sensitive issues

Re: Question from a doctoral student at the University... - Martin Jose...

https://outlook.office.com/owa/#viewmodel=ReadMessageItem&It...

2 of 2 10/22/15, 11:02 AM

Appendix H

Re: Question from a doctoral student at the University of

Wisconsin-□Milwaukee College of Nursing

You can use the PSS 14 in your research; you don't need a formal permission. Just, it is necessary to use the correct citation. The original PSS was design by Cohen et al.

Cohen, S., Kamarak, T. y Mermelstein, R. (1983). A Global Measure of Perceived Stress. Journal of health and social behaviour, 24,385-396.

Our adaptation was validated by Gonzàlez & Landero:

González, M.T. y Landero, R. (2007). Factor Structure of the Perceived Stress Scale (PSS) in a Sample from Mexico. The Spanish Journal of Psychology, 10 (1), 199-206

I'm sending you two papers about it, in the first one you can find the Scale and how to score it. In the second one you can find normative data for men and women

If you need anything else, please write us.

Thank you

Dra. Mónica Teresa González Ramírez

http://www.monica-gonzalez.com/

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De: Martin Joseph Mikell <mjmikell@uwm.edu>

Para: "monygzz77@yahoo.com" <monygzz77@yahoo.com>

Enviado: Lunes, 28 de septiembre, 2015 9:39:29

Asunto: Question from a doctoral student at the University of Wisconsin-Milwaukee College of Nursing

Dra. González Ramírez:

My name is Martin Mikell and I am a doctoral student at the University of Wisconsin-Milwaukee in

Monica T. Gonzalez Ramirez <monygzz77@yahoo.com>

Mon 9/28/2015 6:30 PM

To:Martin Joseph Mikell <mjmikell@uwm.edu>;

2 attachments ({792 KB) } 2007 PSS.pdf; 2013 PSS.pdf;

Re: Question from a doctoral student at the Universi... - Martin Jose...

https://outlook.office.com/owa/#viewmodel=ReadMessageItem&It...

1 of 2 10/22/15, 11:03 AM

the College of Nursing. I am interested in studying Latinos in the Milwaukee area who are at risk for developing diabetes. Attached is a letter which describes my research study and why I am contacting you. Please contact me if you have any further questions, and I look forward to hearing from you.

Thank you,

Martin Mikell

UWM--□CON Doctoral student

Re: Question from a doctoral student at the Universi... - Martin Jose...

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2 of 2 10/22/15, 11:03 AM

Appendix I

From: Binur, Michelle <Michelle.Binur@sagepub.com> on behalf of permissions (US) <permissions@sagepub.com>

Sent: Wednesday, October 7, 2015 3:39 PM

To: Martin Joseph Mikell

Subject: RE: Question from a doctoral student at the University of Wisconsin-Milwaukee College of Nursing

Dear Martin Mikell,

Thank you for your request. You can consider this email as permission to use the material as detailed below in your upcoming dissertation. Please note that this permission does not cover any 3rd party material that may be found within the work. We do ask that you properly credit the original source, Hispanic Journal of Behavioral Sciences. Please contact us for any further usage of the material.

Best regards,

Michelle Binur

Rights Coordinator

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Appendix J

IPAQ questionnaire permission

Follow the link, no permission is needed only proper citation WHEN you publish

https://sites.google.com/site/theipaq/

Martin Mikell <martinmikell2@gmail.com>

Thu 10/1/2015 10:03 PM

To:Martin Joseph Mikell <mjmikell@uwm.edu>;

IPAQ questionnaire permission - Martin Joseph Mikell

https://outlook.office.com/owa/#viewmodel=ReadMessageItem&It...

1 of 1 10/22/15, 11:01 AM

CURRICULUM VITAE

Martin J. Mikell, BSN, RN, CEN, BBA

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Milwaukee, WI 53222
E-mail: martinmikell2@gmail.com

Work:
Clement J. Zablocki VA Medical Center
5000 W. National Ave;
Milwaukee, WI 53295
E-mail: martin.mikell@va.gov

EDUCATION

PhD Candidate	University of Wisconsin-Milwaukee, Milwaukee, WI Graduation in Spring 2017 Area of interest: Pre-diabetes among Mexican Americans
BSN	University of Wisconsin-Milwaukee, Milwaukee, WI – 1998
BBA	St. Norbert College, DePere, WI – 1990
Advanced Technical Certificate	Waukesha Community Technical College, Waukesha, WI - 2005 Medical Interpreter – Spanish

LICENSURE Registered Nurse, Wisconsin

CERTIFICATIONS – Other

Certified Emergency Nurse	Emergency Nurses Association, 09/2013-09/2017
Advanced Certified Life Support	American Heart Association, 11/2015-11/2017
Basic Life Support	American Heart Association, 02/2016-02/2018
Certified Medical Interpreter – Spanish	Waukesha Community Technical College, 05/2005

AWARDS

Doctoral Student Poster Award, Sigma Theta Tau International, Eta Nu Chapter, Midwest Nursing Research Society Conference, Milwaukee, WI: April 2017

Doctoral Student Poster Award, Sigma Theta Tau International, Eta Nu Chapter, Midwest Nursing Research Society Conference, Milwaukee, WI: March 2016

Kate Ellen Polacheck Award, Outstanding RN/Mentor of the Year Award, Aurora Health Care, Milwaukee, WI: April 2010

Jerry Stanzer Leadership Award, University of Wisconsin-Milwaukee, College of Nursing, Milwaukee, WI: December 1998

PROFESSIONAL EXPERIENCE

10/2012 – 10/2013	Research Trainee – Pre-Doctoral with Dr. Mary Hagle Nursing Education and Research Department Funded through the Office of Academic Affairs, Veterans Affairs
11/2012 – Present	Staff Nurse

	Emergency Department Clement J. Zablocki VA Medical Center Milwaukee, WI
2005 – 2010	Wellness Coach Core Health Group Mequon, WI
2004 – 2013	Home Health Nurse Interfaith – Older Adult Programs/ Near South Side Office Milwaukee, WI
01/1999-11/2012	Staff Nurse – Expert Level Emergency Department Aurora Sinai Medical Center– Magnet Hospital Aurora Health Care, Milwaukee, WI
09/1994-08/1997	Latin American Sales Coordinator GB Electrical, Inc. Milwaukee, WI
08/1990-01/1992	International Sales Associate Richardson Electronics, Ltd. La Fox, IL

PUBLICATIONS and PRESENTATIONS

Mikell, M., Snethen, J., Kelber, S. (2017, May). *Exploring factors influencing health promoting behaviors among Latino immigrants*. 19th Annual Southeastern Wisconsin Nursing Research Conference: Building Bridges to Research Based Nursing Practice, Milwaukee, WI. Oral presentation.

Mikell, M., Snethen, J., Kelber, S. (2017, March). *Exploring factors influencing health promoting behaviors among Latino immigrants*. 41th Annual Midwest Nursing Research Society Conference, Minneapolis, MN. Poster presentation.

Mikell, M., Snethen, J., Castro, E. (2016, August). *Perception of factors that contribute to access to health promotion and effective health maintenance among Latino immigrants with low levels of English literacy*. Wisconsin Public Health Association Conference, Public Health Nursing Section, Stevens Point, WI. Poster presentation.

Mikell, M., Snethen, J., Castro, E. (2016, March). *Perception of factors that contribute to access to health promotion and effective health maintenance among Latino immigrants with low levels of English literacy*. 40th Annual Midwest Nursing Research Society Conference, Milwaukee, WI. Refereed poster presentation.

Hagle, M., Boom, V., Mancuso, J., Tennies, S., **Mikell, M**., Hughes, R., Wakefield, B. (2016, March). *Utilization of Home Telehealth by Veterans with Hypertension: Achievement of BP Goals*. 40th Annual Midwest Nursing Research Society Conference, Milwaukee, WI. Refereed poster presentation.

Wilson, C., Breimon, L., Emmer, H., Keehan, E., Pereira, A., Cox, D., Dymond, L., **Mikell, M.**, Schroeder, E., Tennies, S., Reith, V., Blanchette, P., Komers, Wolf, S., Haley, S., Kulick, B., O'Connor, K., Pilliow, T., Singer, M., Vugrinec-Daleiden, R., & Hagle, M. (2015, May). *PIV Electronic Medical Record Documentation: A QI Project.* INS 2015: Annual convention and industrial exhibition. Louisville, KY: Refereed poster presentation.

Boom, V., Hagle, M., Mancuso, J., Tennies, S., **Mikell, M.**, Rein, L., Szabo, A., Hughes, R., Wakefield, B. (2015, May). *A cross-sectional retrospective review of clinical outcomes for veterans with hypertension using telehealth services*. 17th Annual Southeastern Wisconsin Nursing Research Conference: Building Bridges to Research Based Nursing Practice, Milwaukee, WI. Poster presentation.

Hagle, M., Mancuso, J., Rein, L.E., & Szabo, A., **Mikell, M.**, Tennies, S., Bull, M., Hughes, R., & Wakefield, B. (2015, April). *Exploring factors that promote home telehealth utilization among Veterans*. 39th Annual Midwest Nursing Research Society Conference, Indianapolis, IN. Refereed poster presentation.

Milan, J., **Mikell, M.**, Blanchette, P., Hendricks, M., Komers, N., Sanchez, A., Wolf, S. (2015, May). *Facilitating same-day care to a primary care provider for specific patients presenting to an emergency department*. 17th Annual Southeastern Wisconsin Nursing Research Conference: Building Bridges to Research Based Nursing Practice, Milwaukee, WI. Poster presentation.

Hagle, M. E., & **Mikell, M.J**. (2014). Peripheral venous access. In S. M. Weinstein & M.E. Hagle (Eds.), *Plumer's principles & practice of infusion therapy* (9th ed.) (pp. 303-334). Philadelphia, PA: Lippincott Williams & Wilkins.

Mikell, M. (2013, May). *Exploring the perceived health needs and risks of illness among Mexican –American adults within an urban faith-based setting*. 15th Annual Southeastern Wisconsin Nursing Research Conference: Building Bridges to Research Based Nursing Practice, Milwaukee, WI. Poster presentation.

Mikell, M. (2013, November). *Exploring the perceived health needs and risks of illness among Mexican American adults within an urban faith-based setting*. University of Wisconsin-Milwaukee, College of Nursing Convocation, Milwaukee, WI. Poster presentation.

Appearances in Popular Media

Mikell, M. (2016). Estudio de Salud. In J. Pruna (Ed.), *Que Pasa, Wisconsin*: Telemundo.

Professional Service for Local, State and National Nursing Organizations

2004 – 2013	Board of Directors, Interfaith – Older Adult Programs Near South Side Office, Milwaukee, WI
2004 – Present	Wisconsin Nurses Association (WNA)/American Nurses Association

2010 – 2016	Doctoral Nursing Student Association University of Wisconsin-Milwaukee, College of Nursing 2011-2016, Secretary
2013 – Present	Emergency Nurses Association