DIABETES FAMILY HEALTH HISTORY AMONG COLLEGE STUDENTS

A Dissertation

by

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ABSTRACT

Obesity rates have dramatically increased in prevalence among children and adolescents. This increase is complemented by the appearance and increasing prevalence of Type 2 Diabetes mellitus (T2D). The numbers of youth with T2D are estimated to increase from 22,820 people in 2010 to 84,131 people in 2050. The purpose of this dissertation was to: 1) Determine what the extant scientific literature reports on the association between T2D family history status and T2D related-preventive behaviors, 2) Examine differences in T2D knowledge (behavioral and genetic) among college students with and without a family history of T2D, and assess the influence of demographic characteristics (age, biological sex, BMI, race and marital status) and 3) Use Structural Equation Modelling procedures to assess the relative impact of behavioral intention, attitude, perceptions (risk and severity), family history and demographic factors (age, biological sex, BMI, race and marital status) on T2D related-preventive behaviors among college students.

The systematic literature review included 11 studies. We found that majority of the studies provide supportive evidence for the association between a positive T2D family history status and engagement in various protective behaviors such as healthy diets, physical activity and T2D routine screening. However the evidence was inconsistent. We also found that the conceptualization and operationalization of family history status as a construct varied among studies which could possible impact the results.

The second part of the dissertation employed a cross-sectional survey design technique. Data were collected via web-based survey using Qualtrics. A total of 7,600 students were contacted and 909 responded (12% response rate). Participants were undergraduate students (18 or older) enrolled full time or part-time in four colleges/Universities across a large southwestern state. ANOVA, correlations, multiple regression and structural equation analysis were used to answer the study questions using SPSS 2.0.

We found that there was lower T2D genetic knowledge than there was for T2D behavior-related knowledge. Whites had much higher T2D knowledge than minority populations. Age and BMI were significantly related to increased T2D knowledge, and students with a family history of T2D generally knew more about causes of T2D than those without a family history. The conceptual model showed differing paths in both groups (those with and those without a T2D family history).

The results of this study suggest that tailored lifestyle interventions based on T2D family history group that assesses health beliefs/perceptions and emphasizes approaches for preventing T2D may be an effective strategy for reducing the burden of T2D.

DEDICATION

This dissertation is dedicated to my lord and savior Jesus Christ, my parents (Dr.'s Isaac and Elizabeth Amuta), my beautiful niece (Ofure Aisabokhae) and my amazing 'Sugar' (Arturo Jimenez). I love you all so much!

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CHAPTER I

INTRODUCTION

The prevalence of Type 2 Diabetes (T2D) among adults in the United States (U.S.) increased by more than 50% since 1980, making T2D the fastest growing chronic disease in American history (American Diabetes Association, 2013). Also, in the U.S., 35% (79 million) of adults have pre-diabetes and full blown T2D diagnosis are estimated to increase by 165% in 2050 (Boyle et al., 2001). Further, T2D is the main cause of blindness, kidney disease, limb amputations and contributes to the incidence of stroke and heart disease (National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), 2013). The total costs of diagnosed T2D at $245 billion in 2012 from $174 billion in 2007, a 41% increase in five years (American Diabetes Association, 2013).

Obesity rates are on the rise in children and adolescents and T2D is also concurrently increasing in this population because obesity is one of the causes of T2D (Drong, Lindgren, & McCarthy, 2012). Approximately 3,600 youth are newly diagnosed with T2D annually (American Diabetes Association, 2013). Behavioral risk factors for T2D such as obesity, sedentary behavior, smoking and poor eating habits begin at a young age (Bishop, Middendorf, Babin, & Tilson, 2005; Ogden, Carroll, Kit, & Flegel, 2012). The greatest increases in obesity occur in individuals between the ages of 18 to 29 years, during the transition from adolescence to adulthood when many students are in college (Centers for Disease Control & Prevention, 2007).

As the prevalence of T2D reaches epidemic proportions, it is imperative that strategies to prevent T2D are implemented in way of research and programs. These may include targeting individuals with a family history of T2D to increase the effectiveness of

such interventions (Hariri et al., 2006). One study found that the risk for developing T2D can be reduced by approximately 31% for people with a family history of T2D through diet and exercise interventions (Wing, Venditti, Jakicic, Polley, & Lang, 1998). T2D family history education and interventions show some positive effects on lifestyle behaviors. For example, physical activity and diet were found to be more effective than blood glucose lowering medication (Heideman et al., 2011). Another study found that people who had a family history of T2D reported moderate healthier lifestyle changes than those without a family history (Baptiste-Roberts et al., 2007). Furthermore, most studies that examined the influence of T2D family history on behaviors, found positive results, such as: weight loss, increase in physical activity and healthy eating (Pijl et al., 2009; Rautio et al., 2012; Wijdenes et al., 2013; Wing et al.,, 1998). In the prior mentioned studies, college students were not sampled.

Risk factors for developing T2D are prevalent among U.S. college students. For example, alcohol and tobacco use, overweight and obesity, physical inactivity and poor eating habits, high cholesterol, blood pressure, and blood sugar (American College Health Association, 2011). These risk factors may be attributed to the fact that college years characterize a major shift for students because most are living away from home for the first time and are forced to make health-related lifestyle decisions without their parents or guardians. Thus, they may begin adopting behaviors that are not healthy such as binge drinking, smoking, engaging in illicit drug use and poor food choices which make them prone to the development of T2D (American College Health Association, 2011; American College Health Association, 2013). In fact, a prospective study found that 70% of college students have significant weight gain once they start college (Lloyd-

Richardson, Bailey, Fava, & Wing, 2009). The 2013 American College Health Assessment (ACHA) survey showed that about 22% of college students are overweight and approximately 12% are obese. Up to 24% are not involved in physical activity, 16.1% smoke, 5% drink more than 5 alcoholic drinks a day, and only approximately 5% eat five or more servings of fruits and vegetables a day (American College Health Association, 2013). All of these factors can contribute to the development of T2D among college students.

A non-modifiable risk factor closely interconnected to T2D manifestation is family history (Claassen et al., 2010); an individual's susceptibility to T2D is up to six times higher than someone without a family history of T2D because family members share environmental factors that include cultural beliefs and practices such as diet choices and physical activity habits (Claassen et al., 2010; Hariri et al., 2006). The use of family history as a health promotion tool has potential for reducing the epidemic of T2D (Hariri et al., 2006). Thus, there is an emphasis on family history in this study.

The long-term goal of this dissertation is to contribute to the extant body of knowledge that will lead to reductions in the prevalence of T2D in the U.S. The objective of this dissertation is to determine the influence T2D family history has on knowledge, attitudes, intention and behaviors among college students. The rationale is that college students' knowledge of T2D family history and their attitudes and intention towards T2D-related preventive behaviors can scientifically inform health promotion interventions targeted towards college students. To carry out my objective, the three specific aims are: 1) –Describe, synthesize and critically analyze the scientific literature specific to how awareness of a positive family history of T2D is associated with T2D

related-preventive behaviors. 2) Examine differences in T2D knowledge (behavioral and genetic) among college students with and without a family history of T2D, and assess the influence of demographic characteristics (age, biological sex, BMI, race and marital status). 3) Use Structural Equation modeling procedures to assess the relative impact of behavioral intention, attitude, perceptions (risk and severity), family history and demographic factors (age, biological sex, BMI, race and marital status) on T2D-related preventive behaviors among college students.

The result of this dissertation will help design intervention programs for T2D prevention by utilizing different constructs of the Health Belief Model (HBM) and Theory of Planned Behavior (TPB). Since this study is theory based, it will add new information to the scientific literature and to health educators' practice related to college students' overall T2D knowledge, the role of attitudes and intention in explaining their T2D related preventive behaviors and the predictors of attitude toward the behaviors (e.g. family history, beliefs, severity of parents T2D, risk perception and demographic characteristics). The HBM and TPB were combined to create a model. This conceptual model guided the studies presented in this dissertation.

The current studies are innovative because: 1) although there have been studies published on the influence of T2D family history on health protective behaviors, to the best of our knowledge no study has systematically synthesized all of the evidence to report the findings nor carried out a quality assessment of the studies; 2) to the best of our knowledge this is the first study that specifically examined college students as the population of interest. Even though college students are vulnerable to T2D risk factors such as obesity, alcohol abuse, sedentary behavior and it is established that such

behaviors follow to adulthood (Mikkilä, Räsänen, Raitakari, Pietinen, & Viikari, 2004); 3) my third study will use Structural Equation Modelling to examine how the proposed theoretical framework fit the data to explain college students T2D-related health behaviors, to the best of our knowledge, such methods have never been done before; and 4) most studies that explore family history knowledge and T2D-related health behaviors mostly sample Caucasians, however, my sample is from schools that promise a diverse population: Texas A&M University- mainly Caucasian, Prairie View A&M University - historically black, University of the Incarnate Word -Hispanic serving, and Blinn College is multi- ethnic.

This dissertation consists of five chapters. Chapters II, III and IV represent manuscripts that will be submitted to peer-reviewed journals for publication. The following is a description of each chapter:

- Chapter I is a brief overview of the topic being examined throughout this document. Also, the purpose, significance, and innovation of the research project are presented.
- Chapter II documents the extant literature on the influence of T2D family history status on T2D-related preventive behaviors and the methodological quality of the literature reviewed. This chapter is the first journal article.
- Chapter III reports on quantitative findings on the differences in T2D knowledge (behavioral and genetic) among college students with and without a family history of T2D, and assesses the association with demographic characteristics (age, biological sex, BMI, race and marital status). This chapter is the second journal article.

- Chapter IV reports on quantitative findings on the relative impact of behavioral intention, attitude, perceptions (risk and severity), family history and demographic factors (age, biological sex, BMI, race and marital status) on T2D related-preventive behaviors among college students using Structural Equation Modeling techniques. This chapter is the third journal article.
- Chapter V presents the conclusions reached by examining the evidence found in chapters II-IV, Implications for health education and promotion for T2D prevention and recommendations for future research.

CHAPTER II

INFLUENCE OF TYPE 2 DIABETES FAMILY HISTORY ON RELATED PREVENTIVE BEHAVIORS: A SYSTEMATIC LITERATURE REVIEW

Introduction

Type 2 Diabetes (T2D) is a risk factor for many chronic diseases such as stroke and heart disease (American Diabetes Association, 2013). The global burden of T2D is at a steady increase in all countries (Wild, Roglic, Green, Sicree, & King, 2004; Zimmet, 2003). In 2011, 366 million (8.3% of the total world population) people around the world were diagnosed with T2D and by 2030 this number will rise to 552 million people (9.9% of the total world population) (Zimmet, Alberti, & Shaw, 2001). In the United States, approximately 11 million people were diagnosed with T2D in 2000 and are estimated to go as high as 29 million people in 2050 (Boyle et al, 2001).

T2D can be prevented or delayed by changes in lifestyle (physical activity and healthy nutrition), (Centers for Disease Control and Prevention (CDC), 2011). However, there are non-modifiable risk factors that make an individual more susceptible than others (Claassen et al., 2010). Some examples of non-modifiable risk factors are ethnicity, age, gender, history of gestational T2D and T2D family history (Centers for Disease Control and Prevention (CDC), 2011).

Family history of T2D is a construct which encompasses both environmental and genetic risk factors because family members tend to share norms, behaviors, culture as well as biological traits (Claassen et al., 2010). Evidence that T2D runs in families and thus has a genetic component is well documented (Klupa et al., 2000; Malecki et al.,

2002; Mori et al., 2002). An individual's susceptibility to T2D is up to six times stronger than someone without a family history of T2D (Klupa et al., 2000; Mori et al., 2002). Using family history as a health promotion/education instrument is an area that has much potential for reducing the epidemic of T2D (Hariri et al., 2006).

Few studies have assessed the effectiveness of using family history information as a means to communicate disease risk and to motivate at-risk individuals to change lifestyles and maintain healthy ones. Such studies report varying types of association between an individual's T2D family history status and T2D related lifestyle risk reducing behaviors (Baptiste-Roberts et al., 2007; Chang et al., 2011; Forsyth & Goetsch, 1997; Hariri et al., 2006; Omolafe, Mouttapa, McMahan, & Tanjasiri, 2010; Pijl et al., 2009; Slattery et al., 2009; Wijdenes et al., 2013; Zlot et al., 2009; Zlot, Cox, Silvey, & Leman, 2012). However, the literature is inconsistent, thus, the need to synthesize the literature on this topic is imperative.

An extensive literature review has been done on the clinical effectiveness of the family history construct for disease prevention in primary care and for the practice of public health (Heideman et al., 2011). However, we specifically looked at familial risk for T2D status and adoption of T2D related preventive behaviors outside the clinical environment. As far as we know, this is the first extensive review including studies that go beyond merely using T2D family status as an identifier for recruitment for the clinical studies. We specifically included only studies that were either cross-sectional (thereby examined the association between T2D family history and protective health behaviors), or Pre-Post studies that used T2D family history as a vehicle for enhancing intrinsic

motivation to make T2D related lifestyle changes, as a way of preventing T2D or at least lowering the risk.

In the Health education/promotion field, clinical trials are not common. Health educators are mainly restricted to plan theory-based health educational programs that inform individuals about their genetic susceptibility to illness and leave the rest to the targeted individuals' readiness to modify their current behaviors. In addition, health educators can advocate for environmental policy changes to aid and supplement the individual's willingness to adopt healthy behaviors. To date and to the best of our knowledge, there is no systematic literature review that reveals the consensus of the scientific literature on the impact of a positive family history of T2D on personal T2D related-preventive behaviors. Examining the influence of T2D family on preventive behaviors is an important study because family history has been considered a construct for T2D prevention and thus, synthesizing the literature is important to document the effectiveness of the family history construct.

The rationale for conducting a systematic review is well established. Researchers and health policy experts are overwhelmed with various amounts of scientific information; therefore the need for systematic literature reviews to efficiently synthesize the existing scientific information and provide data for informed decision making (Mulrow, 1994).

The purpose of this systematic review is to present answers to the following questions: (1) what does the extant literature say about the association between T2D family history status and T2D-related preventive behaviors? (2) What is the methodological quality of the current existing literature examining the association

between family history of T2D and T2D-related preventive behaviors? The long-term aim of this paper is to aid policy makers, health educators, T2D educators, researchers, medical personnel, geneticists and the host of other health professionals who in one way or another use the family history information for T2D prevention.

Methods

The current systematic literature review is comprised of any study that included an assessment of the association between family history of T2D status and T2D related risk behaviors. The methodology of this study followed the framework provided by Judith Garrard (Garrard, 2013). A trained public health librarian, with experience in organizing and documenting searches for systematic literature reviews, assisted in the search. In addition to the electronic searches, we purled reference lists of the included studies for potentially missed records.

The databases searched include Medline, Embase, CINAHL, Global Health and Psyc INFO. For inclusion in this review, studies had to meet the following criteria: 1) published after 1990 (Human Genome Project start); 2) published in English language; 3) include T2D in the study, 4) include participant knowledge/awareness/risk perception of T2D family history; 5) measure risk-reducing behaviors related to T2D such as nutrition, physical activity, smoking, screening etc.); 6) include persons with a family history of T2D; 7) be peer-reviewed, and 8) be either quantitative or qualitative. All articles published through October 2014 were retrieved (the date in which the search began). Titles, abstracts, and articles were reviewed and coded for eligibility by the primary author.

Information concerning participant characteristics, data items/coding themes include: 1) authors, 2) purpose of study, 3) study design, 4) instrument used 5) how T2D family history is defined, 6) sample characteristics (e.g. size, age, race, gender), 7) theory utilization, 8) data analysis (descriptive, bivariate, multivariate), 9) T2D related risk behavior measured, 12) outcome/results, 10) length of follow-up (for experimental studies), 11) place of participant recruitment, 12) data source, 13) baseline year, 14) effect size and confidence interval.

Each article's methodological quality was examined by assessing its theoretical framework, study sample, reliability reporting, and statistical analyses.

A total of 2,523 articles were initially identified based on the search terms. Search terms included: 'diabetes', 'type 2 diabetes mellitus', 'non-insulin dependent diabetes', 'family history', 'relatives', 'parents', 'genetics', 'behavior', 'physical activity', 'exercise', 'diet', 'nutrition', 'food choice', 'clinical screening', 'smoking', 'attitude', 'perceptions' 'beliefs', 'knowledge'. After removing duplicates (n = 941), 1,582 article abstracts were screened. After abstract screenings, 1,514 articles were excluded based on eligibility criteria leaving 68 articles to be fully examined. Eleven publications met the inclusion criteria and were represented in the final sample. See Figure 1 for detailed article selection and exclusion process.

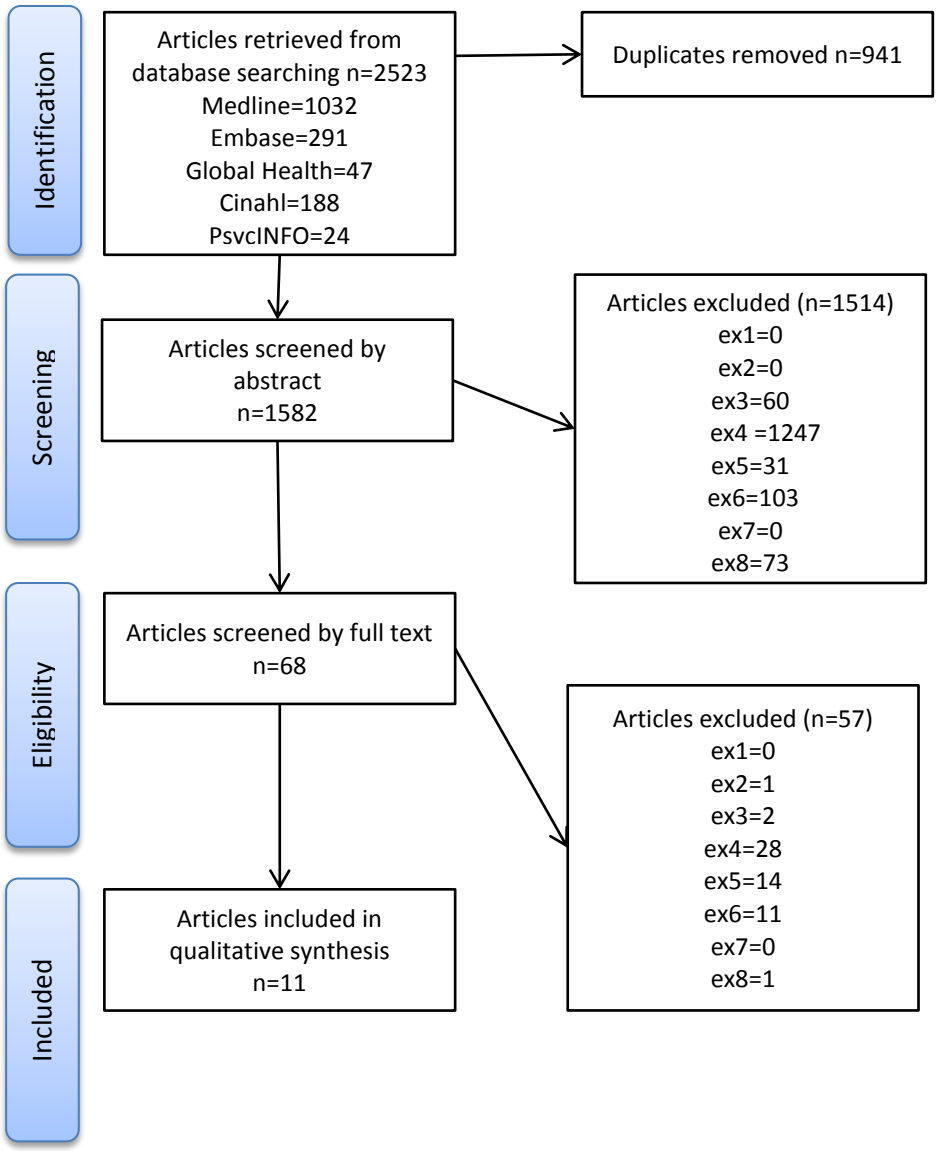

Figure 1**:** Matrix of Study selection

Note*: **ex1**=Published before 1990 (Human Genome Project start); **ex2**=not published in English language; **ex3**= does not include T2D in the study, **ex4**= does not includes participant knowledge/awareness/risk perception of T2D family history; **ex5**= does not measure risk-reducing behaviors related to T2D such as nutrition, physical activity, smoking, screening etc.); **ex6**=does not Include persons with a family history of T2D; **ex7**= the article is not peer-reviewed, and **ex8**= article is not quantitative or qualitative.*

Results

Eleven distinct journals published the 11 studies included in this review. Two journals had a medical focus while the other seven centered on public health and community health. One article was published in the '90s (1997), one article was published in 2006, one in 2007, one in 2008, two in 2009, one in 2010, 2011, 2012 and 2013. Among the reviewed studies, nutrition, physical activity and routine screening were the only T2D related preventive behaviors examined. Nine of the studies employed a cross-sectional survey design while two were pre-post studies. Refer to Appendix B for a complete matrix of article characteristics.

Influence of T2D Family History Status on T2D Related Preventive Behaviors

All eleven studies included in the review showed that those with a family history of T2D were generally more aware of T2D and engaged in some T2D-related preventive behaviors compared to those without a family history.

Physical Activity Behavior

Physical activity behavior was a factor included in most studies, although the influence of T2D family history on physical activity behavior was mixed. Nine studies (Omolafe, Mouttapa, McMahan, & Tanjasiri, 2010; Slattery et al., 2009; Forsyth & Goetsch, 1997; Baptiste-Roberts et al., 2007; Chang et al., 2011; Hariri et al., 2006; Qureshi & Kai, 2008; Wijdenes et al., 2013; Zlot et al., 2009; Zlot, Cox, Silvey, & Leman, 2012) in this review included physical activity/exercise as a behavior of interest. Omolafe et al., and Baptiste et al., found that African Americans with a positive family history of T2D engaged in significantly more physical activity than those with no family history. Similarly, Hariri et al., found that compared to those with average T2D risk (one

second-degree relative or no family history of T2D), people with moderate familial risk ("Only one first- and one second-degree relative with T2D from same lineage; one first-degree relative with T2D mother and father with T2D, or two second-degree relatives from same lineage with T2D") and high familial risk of T2D ("At least two first-degree relatives with T2D from same lineage; one first- and two second-degree relatives with T2D from same lineage; or three second-degree relatives with T2D from same lineage") were more likely to report higher levels of physical activity to prevent T2D. Chang et al., and Zlot et al., also found that adults with a family history of T2D were more likely to engage in greater levels of exercise than adults without a T2D family history (Chang et al., 2011).

In contrast, four studies did not find any impact of T2D family history on physical activity behavior. For example, Slattery et al., and Qureshi et al., found that participants with a T2D family history reported less vigorous physical activity than their counterparts without T2D family history. Furthermore, Forsyth and colleagues found that individuals with a family history of T2D did not significantly differ in exercise behaviors from those without T2D family history. Widjenes et al found that for individuals at familial risk there was no overall intervention effect on exercise behavior after a three months intervention.

Nutrition Behaviors

Nutrition behavior was a behavior of interest for several studies examined; however, the association between T2D family history and nutrition behaviors was inconsistent. Seven studies (Chang et al., 2011; Pijl et al., 2009; Qureshi and Kai, 2008; Wijdenes et al., 2013; Zlot et al., 2009; Forsyth and Goetsch, 1997; Zlot, Cox, Silvey, &

Leman, 2012) included nutrition as part of their study. More specifically, Baptiste et al., found that those with a T2D family history were more likely to consume 5 or more servings of fruits and vegetables per day than those without a family history of T2D. Another study carried out by Pijl et al., found that participants receiving familial risk information reported having eaten more healthy 3 months after they were educated about their familial risk for T2D. Similar to Pijl's study, Quershi et al found that those who were informed of their T2D family history were more likely than those in the non-informed group to report lifestyle changes in their nutrition behaviors. Widjenes et al., found that for individuals at familial risk there was a decrease in self-reported saturated fat intake among low-educated participants. Lastly, both studies carried out by Zlot and Blend et al., and Zlot and Cox et al., found that respondents who reported making lifestyle changes in their diet to reduce the chance of developing T2D had strong or moderate familial risk of T2D than were respondents who did not report making these lifestyle changes. In contrast to the prior mentioned studies, Forsyth and Goetsch et al., found that individuals with a family history of T2D did not significantly differ in nutrition behaviors from those without T2D family history.

T2D Routine Screening Behaviors

T2D Routine Screening Behavior was a behavior of interest for some studies examined, and all studies found a consistent positive influence of T2D family history on T2D screening behaviors. Four studies (Baptiste-Roberts et al., 2007; Forsyth and Goetsch, 1997; Qureshi & Kai, 2008; Zlot et al., 2009) examined the impact of T2D family history on T2D routine screening behaviors. Baptiste et al., found that those with a T2D family history were more likely to have been screened for T2D. Also, Zlot and

Bland et al found that compared with respondents at average risk (no first-degree relatives with T2D or adopted with unknown family history status of blood relatives), respondents with a strong family history (at least 2 first-degree relatives with) were more likely to engage in routine cholesterol screening and other T2D related screenings. Furthermore, Forsyth & Goetsch et al. (2007) found that individuals with a family history differed significantly in routine screening behaviors from those with no T2D family history. Quershi et al. (2008) found that those who were informed of their T2D family history were more likely than those in the non-informed group to report lifestyle changes such as increased routine screening to prevent T2D.

Methodological Quality

The studies' methodological quality was assessed to understand the methods utilized to collect and analyze the data. The use of theory, study sample size, data validity and reliability reporting, how family history was conceptualized and operationalized and analytic methods were examined.

Theory Utilization: Of the 11 articles reviewed, less than half (n = 4) explicitly cited a theoretical framework to guide the research. Two studies used the Health Belief Model (Baptiste-Roberts et al., 2007; Omolafe, Mouttapa, McMahan, & Tanjasiri, 2010), one study used the Theory of Planned Behavior (Pijl et al., 2009) and one study used the Trans-theoretical Model of Behavior change (Zlot, Cox, Silvey, & Leman, 2012).

Study Sample: More than half of the articles (n = 6) reported a sample size larger than 1000 respondents (Baptiste-Roberts et al., 2007; Chang et al., 2011; Forsyth & Goetsch, 1997; Hariri et al., 2006; Qureshi & Kai, 2008; Slattery et al., 2009; Wijdenes et al., 2013). Of the 11 manuscripts, nine reported using secondary data; of these nine, six

used a national sample while two employed state wide samples. Two studies specifically studied African Americans as the population of interest (Baptiste-Roberts et al., 2007; Omolafe, Mouttapa, McMahan, & Tanjasiri, 2010). All 11 studies included both male and female participants.

Data Validity and Reliability: We assessed whether each study reported on the reliability/validity of its data. Among the 11 articles included for review, nine studies reported utilizing items created from other instruments or previous studies. None of the studies (n =11) provided evidence of their own data's reliability (i.e., by reporting their level of internal consistency, through Cronbach's alpha or other types of reliability report).

Measurement of Family History: Family history was inconsistently defined and operationalized across the research literature. Seven studies measured family history as only those who had a first degree relative affected (mother, father, and sibling). One study defined family history as having parents with T2D without consideration of other family members. Three studies classified family history by both first and second degree relatives (mother, father, siblings, uncles, aunts, and grandparents).

Data Analysis Approaches: Five studies combined both Pearson's chi-square tests and multivariate regression (logistic, linear etc.), while three studies employed only regression analysis. One study combined t-tests and Pearson's chi-square. Another study included analysis of variance (ANOVA) and the last study used multivariate analysis of covariance (ANCOVA). See Table 1 for methodological scoring details.

Table 1: Criteria for assessing 11 reviewed studies' methodological quality and distribution of reviewed studies meeting the criteria

Methodological Characteristic	Scoring options Maximum total score = 17	Distribution of reviewed studies meeting criteria	
		Frequency (n)	Percent (%)
Study design	Correlation/Cross-Section design = 1 point	9	82
	Retrospective design = 2 points	0	0
	Prospective Design = 3 points	2	18
Theoretical framework	Study had no theory = 0	7	64
	Study was based on an implicit theory = 1 point	0	0
	Study was based on a specific theory = 2 points	4	36
Sample size	Small sample (<100) = 1 point	2	18
	Medium sample (>100 < 300) = 2 points	1	9
	Large sample (>300) 3 points	8	73
Ethnicity	Not reported = 0 points	0	0
	Reported = 1 point	11	100
Data validity testing	Not Reported = 0 points	0	0
	Reported = 1 point	11	100
Data reliability testing	Not Reported = 0 points	11	100
	Reported = 1 point	0	0
Data analysis	Univariate statistics/descriptive = 1 point	0	0
	Bivariate statistics/ANOVA = 2 points	2	18
	Regression/ANCOVA =3 points	9	82
	Multivariate statistics (canonical correlation analysis, discriminant function analysis, path analysis, structural equation modeling, MANOVA, MANCOVA) = 4 points	0	0
Effect size reporting	Reported effect sizes (R^2, Cohen's d, eta^2, percent of variance accounted for) = 1point	5	45
	Did not report effect sizes accounted for = 0 points	6	55
Clearly defined how T2D Family History construct was conceptualized and operationalized	Clearly defined = 1 points	11	100
	Did not clearly define = 0 points	0	0

Discussion

This systematic literature review was conducted with two main aims. First, we sought to describe what the extant literature reports about the influence of T2D family history on T2D- related preventive behaviors (Physical activity, nutrition, T2D routine screening). Second, we were interested in examining the methodological quality of these studies. Findings from the eleven studies revealed that there was varying impact of T2D family history on physical activity and nutrition behaviors but not for T2D routine screening. Also, this review described these studies' characteristics, methodological quality such as the use of theory, sample size/characteristics, reporting of data's reliability, and data analyses.

Methodological Quality

The methodological quality assessment indicated the reviewed literature suffers from important methodological limitations. More specifically, in examining use of theory, only four of the articles cited a theory to guide the research (Baptiste-Roberts et al., 2007; Omolafe, Mouttapa, McMahan, & Tanjasiri, 2010; Pijl et al., 2009; Zlot, Cox, Silvey, & Leman, 2012). According to the Glanz et al. (2005) "Theory gives planners tools for moving beyond intuition to design and evaluate health behavior and health promotion interventions based on understanding of behavior. It helps them to step back and consider the larger picture" (Theory at a glance, pg. 5). Research based on health behavior theories are not guaranteed to tackle every health problems, but they have a higher likelihood to produce more accurate results which in turn helps with informed programs and policies. With only four of the studies guided by theory, important questions remain regarding these studies contribution to knowledge development.

Validity and reliability reporting helps researchers to assess measurement error and the data's reliability impact on effect sizes and statistical power (Guion, 2002). Unfortunately, none of the eleven studies clearly reported reliability or validity information of their data set. Even though this is bothersome, most of the studies used national or state-wide data sets which are usually thoroughly vetted by health experts. Also, all the studies primarily focused on single item indicators for several of the behaviors reported, which precludes them from assessing alpha levels.

In addition, nine of articles used a multivariate analysis. This depicts some analytic strength because multivariate methods have the ability to examine several independent variables concurrently. Two articles used t-test and ANOVA and both have important limitations. Thus, an examination of methodological quality, such as this one, reveals that research on this topic holds some room for improvement in its analytic approaches.

Family history was measured in different ways; some studies were more conservative as they used only first degree relatives to identify those with a T2D family history (Baptiste etal, 2008; Chang et al., 2011; Forsyth & Goetsch, 1997; Pijl, Slattery et al., 2009; Wijdenes et al., 2013, Zlot et al., 2009; Zlot, Cox, Silvey, & Leman, 2012), while other studies used a broader classification including second and third degree relatives (Omolafe, Mouttapa, McMahan, & Tanjasiri, 2010; Harriri, et al., 2006; Qureshi & Kai, 2008). As T2D family history allows recommendations for T2D prevention and screening to be tailored to one's level of familial predisposition (Claassen et al, 2010), these varying ways of conceptualizing and operationalizing familial risk may create disparities on how T2D familial risk is classified. The family history literature does not

have a standard definition of family history so researchers are left with defining family in whichever way they choose. Thus, the findings from these studies may greatly differ if the way T2D family history was measured changed. The results point to the fact that there is lack of a unified way to define and operationalize family history in the current literature on this topic. Thus creates concern of the validity of the results since the way family history was classified varied significantly.

Impact of T2D Family History Status on T2D Related Preventive Behaviors

Based on the results of this systematic literature review, providing information on T2D family history status to relatives of those diagnosed with T2D in order to promote related lifestyle changes is likely to be more effective than generalized health education messages. Further, informing people of their familial risk for T2D and available preventive strategies such as physical activity and diet enhances their control beliefs regarding prevention of T2D (Hariri, 2006, Valdez et al, 2010).

Health care professionals can play an important role in assisting families at high risk of developing T2D to promote sharing of risk information and discussing preventive opportunities. However, it is still unclear how to best communicate risk information to family members of those who have been diagnosed with T2D, and how that should differ from common strategies to identify people at risk for T2D (Claassen et al., 2010). As the susceptibility for T2D is significantly increased in certain ethnic groups, females and older people, the appreciation of such non-modifiable specific issues warrants special attention in this context. The identification of health and illness beliefs that contribute to an individual's perception of disease risk may help to determine the key elements for tailoring individualized health messages (Claassen et al., 2010). Therefore, the task at

hand is to educate people about their T2D risk, particularly high-risk relatives, to thoroughly and accurately comprehend the potential benefits of prevention and thus make informed choices about sustainable lifestyle modification.

This review points to some significant findings: 1) the fact that we found only three Randomized Control Trials (RCT's) aimed at relatives of those with T2D suggests that family history is an underutilized but potentially effective strategy to reach a defined group of people at risk for T2D; 2) the majority of the reviewed studies provide supportive evidence for the effectiveness of a positive T2D family history status and engagement in various protective behaviors such as healthy diets, physical activity and routine screening; 3) none of the studies reviewed focused primarily on adolescents or young adults and the literature has shown repeatedly that lifestyle behaviors developed at a young age may continue into adulthood and subsequently become more difficult to change as an adult (Mikkilä, Räsänen, Raitakari, Pietinen, & Viikari, 2004).

Thus, it is important to study young people and devise timely interventions while they are still young. Appropriately designed programs focusing on lifestyle improvements need to be targeted toward this high-risk group to delay or prevent the development of T2D; 4) this review exposed the fact that there are no existing qualitative studies that have explored this area of research, even though qualitative studies are a very rich source of information into understanding people on a deeper level.

Limitations

Although this review contributes to the literature by synthesizing research on the association between T2D family history status and engagement in T2D-related protective behaviors, there are limitations that need to be mentioned. First, this review excluded

clinical studies that only used family history as one of the many criteria to recruit participants. This implies that we may have lost some information useful to this study; however, the aim of this study from the start was to exclude such studies and focus on only studies that included participants based mainly on T2D family history status. Second, this study excluded studies that were not published in the English language; it is possible that some studies were left out based on this criterion.

Despite these limitations, this review provides the first study examining and organizing literature exclusively focusing on T2D family history status and engagement in T2D-related protective behaviors. A salient finding was that having a positive T2D family history is generally related to T2D related protective behaviors among adults. This finding suggests that the medical and health promotion professional should include family history information when designing health programs as T2D family history status information can be utilized to personalize health messages.

These messages may be more effective in encouraging people to adopt and maintain a healthier lifestyle behavior than standardized or regular health messages. However, more studies are needed to investigate the effectiveness of using family history information as a personalized tool for T2D prevention, to explore the effectiveness of differentiation of health education messages based on family history information (high vs. low vs. no familial risk) and to identify parts of an intervention that are most effective in achieving permanent lifestyle changes. Also, further studies can explore why the impact of T2D family history on physical activity and nutrition behaviors vary opposed to the impact on T2D routine screening behaviors.

CHAPTER III

TYPE 2 DIABETES KNOWLEDGE AMONG COLLEGE STUDENTS WITH AND WITHOUT A FAMILY HISTORY OF TYPE 2 DIABETES

Introduction

Type 2 Diabetes Incidence and Prevalence

Obesity rates have dramatically increased in prevalence among children and adolescents, complemented by the appearance and increasing prevalence of Type 2 Diabetes mellitus (T2D). T2D prevalence rates are rising in the US, especially among adolescents (Centers for Disease Control and Prevention (CDC) (2011). While T2D has historically manifested in adulthood (de Miguel-Yanes et al., 2011; Fisher et al., 2002), incidence and prevalence rates among teenagers is rapidly rising (Kaufman, 2011). The number of youth diagnosed with T2D is estimated to increase from 22,820 people in 2010 to 84,131 people in 2050 (Imperatore et al., 2012). For the general population, it is projected that the incidence of individuals with a positive diagnosis of T2D will increase by 165% by the year 2050 (Boyle et al., 2001).

Genetics and Family History as a Factor

T2D is a multifactorial disease involving the intricate interaction between modifiable and non-modifiable risk factors (e.g., obesity, ethnicity, gender and age) (Claassen et al., 2010). Non-modifiable factors such as genetics are noteworthy given that parents, children and full siblings may share up to 50% of their genes, grandparents may share up to 25% of genes while maternal or paternal cousins share 15% of genes (Valdez, Yoon, Qureshi, Green, & Khoury, 2010). Therefore, family history status can provide

awareness into some health related conditions that are common in the family lineage. In addition to genetics, families share beliefs, views, and behaviors which usually influence the type and amount of food they eat as well as the amount of physical activities they participate in. Furthermore, family members and relatives also share environmental factors, such as living space, neighborhood risk/protective factors, that can also influence T2D risk (Claassen et al., 2010),. Thus, family history is an ideal indicator of risk of developing a disease like T2D.

Given that the onset of T2D can be delayed or prevented by lifestyle changes such as increasing physical activity behavior, choosing healthier foods and engaging in routine screening (Center for Disease Control Prevention, 2011), having knowledge of the separate and joint contribution of genetic and behavioral factors in the development of T2D remains a central point toward T2D prevention and control (Heideman et al., 2011). Although knowledge may not directly influence health behaviors, both the Health Belief Model and Theory of Planned Behavior have knowledge as one of its constructs predicting perceptions of risk and severity and attitudes towards the behavior (Rimer & Glanz, 2005).

College Students as a Population of Interest

College students represent a significant part of the overall population in the U.S.; in fact, between 1999 and 2009, the number of 18- to 24- year-olds increased from 26.7 million to 30.4 million (National Education Statistics, 2011) and most college students fall within this age range. Approximately 22% of college students are overweight and approximately 12% are obese (American College Health Association, 2011). Furthermore, up to 24% are not involved in physical activity, 16.1% smoke, 5% drink

more than five alcoholic drinks a day, and only approximately 5% eat five or more servings of fruits and vegetables a day. Also, college years characterize a major shift for students because most are living away from home for the first time and may have inexperience in planning healthy/balanced meals or cooking. All of these factors can contribute to the development of T2D among college students (American College Health Association, 2013).

The prevalence of T2D related risk factors among college students may be because many college students do not see T2D as a threat to their health (e.g. poor nutrition and sedentary behavior); thus, they may continue to engage in risky behaviors, making them susceptible to the development of T2D when they grow older (Smith et al., 2012). Also, it is critical that empirical studies better understand how these constructs are demonstrated in college students. It becomes important that college students are equipped with a clear understanding of what, and how, risk factors contribute to the development of T2D. Therefore, the university setting provides a unique opportunity to reach many young adults through disseminating T2D risk-reduction information.

The purpose of this study was to examine the differences in T2D knowledge among a sample of college students with and without a family history of T2D, and assess the influence of demographic characteristics. This aim is guided by two research questions:

1) Does knowledge of T2D differ by T2D family history status?
2) Are there relationships among demographic characteristics of students and T2D knowledge?

Methods

Procedure

Participants were recruited via administrative academic advisors in various participating institutions. Academic advisors sent out emails containing the survey link to students, soliciting their participation. Prior to participation, students were informed that the survey was completely voluntary and informed consent was provided. A total of 7,600 students were contacted and 909 responded (12% response rate). Data were collected via web-based survey using Qualtrics. This study employed a cross-sectional survey design technique. All procedures were evaluated and approved by the appropriate Institutional Review Boards of each participation institution.

Measures

Family history of T2D and demographic characteristics were the primary independent variables in this study.

*T2D Family History***:** Family history was assessed via the item: "Have any of your family members (mother, father, brother, sister, grandparents on both mother's and father's side, aunts and uncles on both mother's and father's side and cousins on both mother's and father's side) ever been diagnosed with Type 2 Diabetes?" Possible responses were "No", "Yes", "I don't know" and "Not applicable". Responses were coded to create a dichotomous outcome variable for T2D family history status, such that "Yes" (coded 1) indicated a positive family history while "No", "I don't know" and "Not applicable" (coded 0) indicated no family history of T2D. The question used to assess family history was adapted from the questionnaire originally used by Baptiste-Roberts

and Colleagues (2007) to assess family history of T2D among African Americans and was adapted to include extended family members.

Demographic Variables: Demographic characteristics such as age, marital status, race/ethnicity, Body Mass Index (BMI) and biological sex were used in the analysis as predictors of T2D knowledge and T2D family history status. Demographic variables were derived from the American College Health Survey Questionnaire.

T2D Knowledge: Knowledge of five known risk factors for T2D (family history, genes, being overweight, lack of exercise, lack of routine clinical screening) was assessed. The questions used to assess T2D knowledge were adapted from the questionnaire originally used by Baptiste-Roberts and Colleagues (2007) to assess knowledge of risk factors in African Americans and were presented with a four point Likert scaled response option (Baptiste-Roberts et al., 2007). Participants were asked to classify each risk factor of developing T2D as "I don't know" (coded as 0), "definitely does not decrease (coded as 1)," "probably does not decrease (coded as 2)," "probably decreases (coded as 3)," and "definitely decreases (coded as 4)". Responses to each of these items were added together to create a single, continuous and composite indicator of knowledge. Higher scores indicated that the participant was more knowledgeable about risk factors for T2D. The knowledge scales exhibited good internal consistency ($\alpha = 0.78$).

Content validity of the questionnaire was established by two specific procedures. First, five experts in health education, research methods and nutrition reviewed the instrument items for relevance and content coverage. After adequate instrument revisions were made, a purposive pilot sample of 17 first year undergraduate students was

employed to determine whether participants could read and correctly interpret questions and respective response scales (data from the pilot study were excluded from subsequent analyses). For this present study, we examined questions assessing knowledge of T2D risk factors, family history of T2D status and demographic characteristics of college students.

Participants

Participants were undergraduate students (18 or older) enrolled full time or part-time in four colleges/universities across a large southwestern state in the US. The sample consisted of a majority of females (81.5%; n=736). Most of the respondents were White (68.2%; n= 616) and the average age was 20 years old. Participants who had a family member diagnosed with T2D were (48.8%; n=441) while those without a family member diagnosed with T2D were (51.2%; n=462). Calculated Body Mass Index (BMI) from the self-reported height and weight data showed that about 3% were underweight, 61% were normal weight, 22% overweight, and 14% were obese. See Table 2 for more details.

Table 2: Demographic Characteristics of College Students

	N=905	Percentage %
BIOLOGICAL SEX		
Male	163	18.1
Female	736	81.5
ETHNIC GROUP		
White	616	68.2
Black/African-American	87	9.6
Hispanic/Latino	218	24.1
Asian	48	5.3
American Indian/AA	22	2.4
FAMILY HISTORY OF TYPE 2 DIABETES		
No	462	51.2
Yes	441	48.8
AGE		
18	124	13.7
19	192	21.3
20	243	27.9
21	216	23.9
22	96	10.6
23	21	2.3
24	8	0.9
25	1	0.1
27	1	0.1
BMI		
Underweight	26	3
Normal Weight	551	61
Over Weight	199	22
Obese	125	14
MARITAL STATUS		
Never Married	28	3.1
Married	872	96.9

Note: Race/Ethnicity equals more than 100 because participants were given the option to select multiple race/ethnicity categories

Data Analysis

Descriptive: Description of students' overall T2D behavioral and genetic knowledge, including stratification by demographic characteristics (age, gender, marital status, Body Mass Index (BMI) and race/ethnicity) was assessed.

One Way ANOVA: we used a one-way ANOVA analysis to test for differences between groups. The dependent variable was T2D composite knowledge score while independent factors were marital status (Not single coded as 0; single coded as 1), family history status (Negative and I don't know coded as 0; positive coded as 1), race/ethnicity (Hispanic coded as 1, African American/Black coded as 2, White coded as 3, Asian coded as 3, Pacific Islander/Alaskan Native coded as 4) and biological sex (male coded as 0, female coded as 1).

Correlation: T2D composite knowledge score and family history status were correlated to examine the extent of any relationship. We used point-biserial correlation because family history is nominally measured while knowledge is an interval measurement. Also, knowledge was correlated with age and BMI.

Pearson's chi-square: Bivariate analyses included Pearson's chi-square tests to examine differences between the positive family history and the negative family history groups on each separate T2D knowledge variable.

Binomial Logistic Regression: We used this analysis to test the association between family history (yes/no) status and demographic characteristics.

Multiple Linear Regressions: Influence of demographic characteristics and family history status (independent variables) on total knowledge of T2D risk factors (dependent variable),

All analyses were carried out using SPSS version 22.0. Cases with missing values were deleted list wise from the subsequent analyses and students who identified as adopted (n=4) were excluded from the analyses leading to a final sample size of 905.

Results

The present study sample consisted of a majority of females (81.5%; n=736). Most of the respondents were White (68.2%; n= 616) and the average age was 20 years old. Refer to Table 1 for a more detailed description of demographics. The majority of participants (n=386; 42.8%) said that *weight loss* definitely decreases a person's chance of developing T2D; most participants (n=620; 68.8%) said a *healthy diet* definitely decreases a person's chance of developing T2D; (n=587; 65.2%) said a *regular exercise* definitely decreases a person's chance of developing T2D. Only a few participants (n=176; 19.6%) said *routine T2D clinical screening* definitely decreases a person's chance of developing T2D and even fewer participants (n=41; 4.6%) said an individual is likely to develop T2D because of a *family history*.

Demographic Characteristics of Students and Type 2 Diabetes knowledge

We used a one-way ANOVA analysis to test for mean differences between categorical demographic characteristics (i.e. biological sex, marital status, race/ethnicity, family history status). There was no statistically significant mean difference for T2D knowledge scores between male and female participants ($F=0.44$; $p>0.005$). Single participants had no statistically significant mean difference onT2D knowledge from those who were married ($F=0.41$, $p>0.05$). Participants who identified as White had the highest T2D knowledge scores while those who identified as Black/African American and Pacific Islander/Alaskan Natives had the lowest T2D knowledge scores ($F=3.38$,

$p<0.05$;). Tukey Post Hoc comparison tests showed that the only statistically significant difference in T2D knowledge was between Whites (mean=19.5, SD=3.63) and African American/Black (mean=18, SD=5.52) ($p<0.05$).

T2D knowledge scores and age had a positive statistically significant correlation ($R=0.82$, $p<0.05$) while BMI had a negative statistically significant correlation ($R=-0.068$, $p<0.05$). Point biserial correlation between T2D knowledge and family history showed a positive correlation with one another ($R=0.18$, $p<0.00$).

Type 2 Diabetes Knowledge and Family History Status

The chi square result showed that there were statistically significant differences between those with and without a family history of T2D on each separate T2D knowledge variable. Weight loss ($\chi2 = 20.16$, $p = 0.000$), healthy diet ($\chi2 = 25.09$, $p <0.001$), regular exercise ($\chi2 = 32.06$, $p < 0.000$), routine clinical screening ($\chi2 = 16.49$, $p = 0.002$), genes ($\chi2 = 16.22$, $p < 0.003$) and family history ($\chi2 = 16.97$, $p =<0.05$).

Multivariate linear regression investigating the influence of demographic characteristics and family history status on total knowledge of T2D risk factors revealed that the only statistically significant predictors of T2D knowledge were family history of T2D ($\beta=0.193$, $p<0.005$) and BMI ($\beta = -0.069$, $p<0.05$). Such that, compared to those without a family history of T2D, those with a family history of T2D have 0.193 standard deviation increase in T2D knowledge controlling for the effect of other independent variables (i.e. biological sex, marital status, and race/ethnicity). Also, the regression coefficient estimates that a one pound increase in weight was associated with an average 0.069 decrease in T2D knowledge holding constant the effect of the other independent variables. See Table 3.

Table 3: Multiple Linear Regression Analyses showing the Influence of Demographic characteristics and Type 2 Diabetes Family History on Type 2 Diabetes Knowledge among college students (n=905)

Variable	*B*	*SE B*	*β*	*t*	*p*
Students Type 2 Diabetes Knowledge					
Constant	15.293	2.22		6.89	.000
Gender	-.312	.365	-.028	-.856	.392
Age	.154	.105	.050	1.471	.142
Hispanic/Latino	.086	.455	.009	.189	.850
Black/African-American	-1.02	.655	-.071	-1.560	.119
White	.339	.151	.080	2.253	.137
Asian	.339	.226	.020	1.504	.612
PI/AA	-.164	.945	-.006	-.174	.862
Body Mass Index	-.112	.234	-.069	-.993	**.035**
Family History Status	1.163	.279	.193	5.846	**.000**
R	0.242				
R^2	0.058				
F	*6.130**				
df	9				

Binary logistic regression showed a statistically significant relationship between T2D family history status and gender (β = 0.508, OR = 1.66, 95% CI = 1.167 – 2.367, p<0.05). This means that female participants were more likely to have/report a family history of T2D than males. Also, being Hispanic/Latino was statistically significantly related to having a T2D family history (β = 0.510, OR = 1.75, 95% CI = 1.063 – 2.608, p<0.05). This means that Hispanic students are almost twice as likely as other races to have a family member diagnosed with T2D. See Table 4.

Table 4: Multivariate Binary Logistic Regression Analyses showing the relationship between Demographic characteristics and Type 2 Diabetes Family History Status (n=905)

Variable	*B*	*SE B*	*OR*	*Wald*	*p*
Students Type 2 Diabetes Family History Status					
Constant	-1.258	1.109	.284	1.287	.257
Gender	.557	.184	1.746	9.171	**.002**
Age	.041	.053	1.014	.068	.795
Hispanic/Latino	.510	.229	1.665	4.957	**.026**
Black/African-American	.389	.327	1.457	1.409	.235
White	-.195	.249	.823	.615	.433
Asian	-.523	.370	1.597	1.601	.206
PI/AA	-.523	.490	.593	1.140	.286
Body Mass Index	.302	.121	1.000	.028	.866
Marital Status	.415	.319	1.514	1.697	.193

Discussion

The aim of this study was to examine differences in T2D knowledge among college students with and without a family history of T2D, and assess the influence of demographic characteristics (biological sex, marital status, race/ethnicity, family history status).

Our results show that college students have relatively low T2D genetic and family history knowledge compared to T2D-related behavioral knowledge (physical activity, nutrition, routine screening). Consistent with our findings, another study found that genetic knowledge about T2D and other chronic diseases are low compared to behavioral knowledge (Claassen et al., 2010). An explanation for such knowledge disparity may be because many health education messages are just beginning to include genomics related information. Further, approximately half of sample of U.S. health educators did not value the incorporation of genomics into public health practice (Chen & Goodson, 2007).

Also, we found that T2D knowledge was higher among Whites than other minority racial groups. Blacks and American Indians/Alaskan Natives had the lowest T2D knowledge scores. Several other studies have found similar results that show a significant T2D knowledge disparity between Whites and other racial groups (Casagrande et al., 2012). These results are a cause for concern as T2D is more prevalent among these racial minority groups (McBean, Li, Gilbertson, & Collins, 2004). Similar to another study (Baptiste-Roberts et al., 2007) we found that those with a positive family history of T2D had a greater knowledge of T2D-related risk factors.

Furthermore, our results showed that age and T2D knowledge were positively correlated with each other, such that T2D knowledge increased with age. This finding is consistent with another study (Gruber & Hu, 2013). However, BMI had a negative statistically significant correlation with T2D knowledge, meaning that students who have higher BMI had less T2D risk related knowledge. The prior result is troubling because people with higher BMI scores indicate that they are likely overweight or obese and thus, has a greater chance of developing T2D (Gómez-Ambrosi et al., 2011; Perry et al., 2012; Rorive, Letiexhe, Scheen, & Ziegler, 2005). This highlights the need for health professionals and health educators to pay attention to this group of students to educate students about their T2D risk and related health behaviors.

Female students were more likely to report a family history of T2D than male students. This result was similar to those of Bastiste-Robert et al. (2007) and Annis, Caulder, Cook, & Duquette, (2005), who found that more women than men reported having a close family member with T2D. Furthermore, women were more likely than men to regard family history as an essential part of their own health and were also more

likely than men to collect family health records (Annis et al., 2005; Baptiste-Roberts et al., 2007).

Our study also found that Hispanic/Latino students were significantly more likely to have a family member diagnosed with T2D compared to other races. This result is similar to another study that found that the prevalence of total T2D (both diagnosed and undiagnosed) among all Hispanic/Latino groups are roughly 16.9% for both men and women, compared to 10.2% for non-Hispanic Whites (Cusi & Ocampo, 2011).

Even though T2D family history cannot be modified (Hariri, Yoon, Moonesinghe, Valdez, & Khoury, 2006), communicating familial risk information to students may be useful in making them more aware of their potential risk for T2D, thus encouraging T2D related protective health behaviors. Family history information can contribute to health program interventions for those who are at increased risk to potentially prevent or delay development of T2D and thus improve health outcomes (Claassen et al., 2010; Pijl et al., 2009).

Health educators have an excellent opportunity to reach the majority of young adults by conveying T2D risk reduction information through college health programs as the college setting is an exceptional place to promote T2D related protective behaviors. Also, as college students are usually educated members of the society, they might be considered as role models and could promote healthy behaviors in the community. In addition, college health educators can also work on providing T2D screening programs for students who are at high risk for T2D based on family history information collected at college based health clinics. Most of the risk factors for developing T2D are lifestyle

related and can be prevented by providing health education to this population (Claassen et al., 2010; Pijl et al., 2009; Qureshi & Kai, 2008).

Limitations and Conclusions

Some limitations of this study deserve mention. First, this study was cross-sectional; therefore, we cannot define causal relationships so we are restricted to associations. Second, the data for this study were obtained via self-report and may have resulted in inaccurate/bias information. Third, some cases of T2D are not yet diagnosed (Centers for Disease Control and Prevention (CDC), 2011); thus, it is probable that students may not have correct facts about their T2D family history status which results in miss-classification of T2D risk.

In conclusion, although T2D family history cannot be modified, communicating familial risk information to students may be useful in making them more aware of their potential risk for T2D and possibly encourage T2D related protective health behaviors. An essential first step is to include active participation from health educators, school physicians and other healthcare professionals to incorporate T2D familial risk education for this young population. According to the Centers for Disease Control (CDC), health educators are encouraged to promote genomics education for the various communities they serve and they are equally charged to also make genomics education a component of planning health education programs (Centers for Disease Control and Prevention, 2001). At the same time, it is essential to note that informing young people about their familial risk for T2D may produce a sense of fatalism if they see their risk for T2D as deterministic which may make them care less about healthy behaviors (Fisher et al., 2002). Therefore, health educators and other health professionals are tasked with

understanding the situations in which T2D genetic/family history risk information encourages behavior modification and develop T2D prevention interventions to eliminate or delay the onset of T2D.

CHAPTER IV

AN ASSESSMENT OF THE RELATIVE IMPACT OF BEHAVIORAL INTENTION, ATTITUDE, PERCEPTIONS, FAMILY HISTORY AND DEMOGRAPHIC FACTORS ON TYPE 2 DIABETES-RELATED PREVENTIVE BEHAVIORS AMONG COLLEGE STUDENTS

Introduction

Type 2 diabetes (T2D) is a serious health condition that can have a negative impact on the health, quality of life, and life expectancy of individuals (Control, Prevention, Control, & Prevention, 2011). Because T2D is a chronic disease that necessitates lifelong maintenance, it is also a tremendous economic burden on the U.S. health care system (American Diabetes Association 2013). The total cost of diagnosed T2D was approximately $245 billion in 2012 from $174 billion in 2007, a 41% increase in five years (American Diabetes Association, 2013). T2D has been defined as "adult onset" disease (de Miguel-Yanes et al., 2011, Fisher et al., 2002), as T2D becomes more common, cases of T2D are being observed in children and adolescents (Bloomgarden, 2004; Dabelea et al., 2012). As a result, the recent increase in the incidence of T2D is assumed to be closely associated to the growing incidence of obesity in young people, which has reached epidemic proportions in the U.S. (Gómez-Ambrosi et al., 2011a).

Physical Activity and Type 2 Diabetes

Physical activity is a critical factor in the prevention of T2D. For example, a prospective study followed 1,110 study participants with no prior history of T2D for five years and found that participants who were regularly engaged in moderate exercise were

up to 65% less likely to develop T2D compared to those who had a sedentary lifestyle (James et al., 1998). Physical activity is associated with lower rates of T2D among men (Joseph, Svartberg, Njolstad, & Schirmer, 2010) and among women (Hu et al., 1999; Weinstein et al., 2004). In addition, a meta-analysis review of ten prospective studies of adults found that moderate intensity exercise such as brisk walking significantly reduced the risk of T2D (Jeon, Lokken, Hu, & van Dam, 2007). Among college students, a cross-sectional study found a strong correlation between aerobic exercise and reduced risk for T2D (Owens, 2008).

Fruit and Vegetable Consumption and Type 2 Diabetes

Fruit and vegetable consumption are also linked to T2D risk/prevention. Fruits and vegetables contain many beneficial nutrients and phytochemicals that are thought to protect against the occurrence of T2D (Harding et al., 2008; Liu et al., 2004). High intake of fruit and vegetables are associated with a reduced incidence of T2D. For instance, high intake of fruit and green leafy vegetables increased glucose metabolism (Sergeant et al., 2001). Similarly, consumption of green leafy vegetables and fruit was associated with a lower threat of developing T2D in the general population (Bazzano, Li, Joshipura, & Hu, 2008) and among overweight women (Liu et al., 2004b). Further, an increase in the consumption of vegetables and legumes during the 20-year prospective study was significantly associated with healthier glucose levels (Feskens et al., 1995). A more recent cohort study found that the mean daily intake of fruits and vegetables, as well as the percentage of participants consuming five or more fruits and vegetables per day, was lower among those who developed T2D than among those who did not develop T2D (Ford & Mokdad, 2001).

Youth and Type 2 Diabetes

Annually, about 3,600 youth are diagnosed with T2D (American Diabetes Association, 2013). Youth, especially college students, are thought to be more at risk for T2D as they tend to significantly gain weight once they start college (Lloyd-Richardson, Bailey, Fava, & Wing, 2009). College years characterize a major shift for students because most are living away from home for the first time. Students are forced to make health-related lifestyle decisions without their parents or guardians. Thus, they may begin adopting behaviors that are not healthy such as binge drinking, smoking, engaging in illicit drug use and poor food choices which make them prone to the development of T2D. Additionally, youth are more at risk also because the most rapid decline in physical activity (PA) occurs during adolescence and young adulthood (Caspersen, Pereira, & Curran, 2000; Dumith, Gigante, Domingues, & Kohl, 2011).

Approximately 22% of college students are overweight, approximately 12% are obese, about 24% reported not engaging in physical activity, up to 16.1% smoke, 5% drink more than five alcoholic drinks a day, and only approximately 5% eat five or more servings of fruits and vegetables a day (American College Health Association, 2013). All of these factors can contribute to the development of T2D among college students. This young population is important to study as research has shown that behaviors learned at a young age are carried on to adulthood (Mikkilä, Räsänen, Raitakari, Pietinen, & Viikari, 2004).

Family History and Type 2 Diabetes

Family history is highlighted as an especially important indicator of T2D because in addition to environmental influences it also reflects inherited genetic susceptibilities to

diseases (Klupa et al., 2000). For example, first degree lineages share about 50% of genetic makeup, second degree lineages share about 25% of genetic make-up and third degree lineages share about 15% genetic make-up (Valdez et al., 2010). To study how T2D is manifested through genes the entire genome of affected family members is scanned, and the families are followed over several generations and then large numbers of affected sibling-pairs are studied. To date, only two genes, *calpain 10* and *hepatocyte nuclear factor 4 alpha*, have been identified as the major genes that cause T2D through this technique (Sladek et al., 2007). Consequently, family history might provide insights into specific conditions that "run in the family/bloodline" (i.e., persons exhibit a predisposition for based on genetic make-up).

Regarding more social and environmental influences on T2D, family members tend to share living space, food preferences, values, and perceptions towards T2D related preventive health behaviors (Claassen et al., 2010, Hariri et al., 2008). Thus, family history of T2D may be a useful tool to identify individuals at increased risk of the T2D and target behavior modifications that could theoretically delay the onset of T2D and thus improve health outcomes (Harrison et al., 2003). It is important to note that although family history is an ideal indicator of risk of developing a T2D, this in no way indicates certainly that T2D will appear if a family member is diagnosed with the condition themselves (Claassen et al., 2010).

Conceptual Model

The Health Belief Model (HBM) and Theory of Planned Behavior (TPB) were combined to create a conceptual model to guide this study. The underlying concept of the HBM is that health behavior is mostly determined by personal beliefs or perceptions of

risk and severity about a disease (Janz & Becker, 1984). Perceived severity refers to a subjective evaluation of the severity of a health problem and its potential consequences. The HBM proposes that individuals who perceive a given health problem as serious are more likely to engage in behaviors to prevent the health problem from occurring (or reduce its severity) (Rimer & Glanz, 2005). Risk perception refers to subjective assessment of risk of developing a health problem such as T2D. The HBM predicts that individuals who perceive that they are susceptible to a particular health problem will engage in behaviors to reduce their risk of developing the health problem. While, individuals who believe they are at low risk of developing an illness are more likely to engage in unhealthy, or risky, behaviors (Rimer & Glanz, 2005).

Risk perception of T2D among those with a family history of T2D showed that, compared to those at average risk perception, people with high or moderate risk were more likely to make lifestyle changes to prevent T2D (Zlot, Cox, Silvey, & Leman, 2012). Understanding students' risk perceptions and how this predicts engagement in T2D related preventive behaviors, particularly those with a family history of T2D, is critical because they are at increased risks for T2D compared to those without a family history (Claassen et al., 2010).

The TPB was formulated to predict an individual's intention to engage in a behavior (Ajzen, 2011). The TBP was developed to explain all behaviors over which people have the ability to wield self-control (Ajzen, 2011; Rimer & Glanz, 2005). The constructs represented in the conceptual model used for the study were attitudes, behavioral intention, and knowledge of risk factors for T2D. Attitudes refer to "the degree to which a person has a favorable or unfavorable evaluation of the behavior of

interest. It entails a consideration of the outcomes of performing the behavior" (Ajzen, 2011). Behavioral intention refers to the "motivational factors that influence a given behavior where the stronger the intention to perform the behavior, the more likely the behavior will be performed" (Ajzen, 2011). The key component of the TPB is behavioral intention; behavioral intentions are influenced by the attitudes towards the health behavior of interest (Rimer & Glanz, 2005).

The hypothesis embedded in this study is that based on the HBM and TPB constructs, predictors of behaviors are rooted in both attitudes and behavioral intention. However, there are other constructs such as family history, beliefs/knowledge, severity of relatives T2D, risk perception and demographic characteristics that may indirectly influence behaviors but more directly influence attitudes (See Figure 1). The objective of this study is, therefore, to assess the relative impact of family history, demographic factors (age, biological sex, BMI, race and marital status), perceptions (risk and severity), behavioral intention and attitude, on T2D related-preventive behaviors among college students. Utilizing Structural Equation Modelling (SEM) procedures will facilitate the evaluation of relationships among various latent (i.e., unobservable) variables proposed in the conceptual model.

The result of this study will help design intervention programs for T2D prevention by utilizing different constructs of the HBM and TPB. This study will add new information to the scientific literature and to health educators practice about college students overall T2D knowledge, the role of attitudes and intention in explaining their T2D related preventive behaviors and the predictors of attitude toward the behaviors (e.g. family history, beliefs, severity of parents T2D, risk perception and demographic

characteristics). In this study, we report on an investigation designed to answer the following questions:

a. What are the significant predictors of attitude?

b. How is family history status/factors related to attitude, behavioral intention and T2D related preventive behaviors?

    i. What is the relationship between attitude and behavioral intention?

    ii. What is the relationship between behavioral intention and T2D related preventive behaviors?

Part “A” of Figure 2 and 2 illustrate the model being examined for the first question.

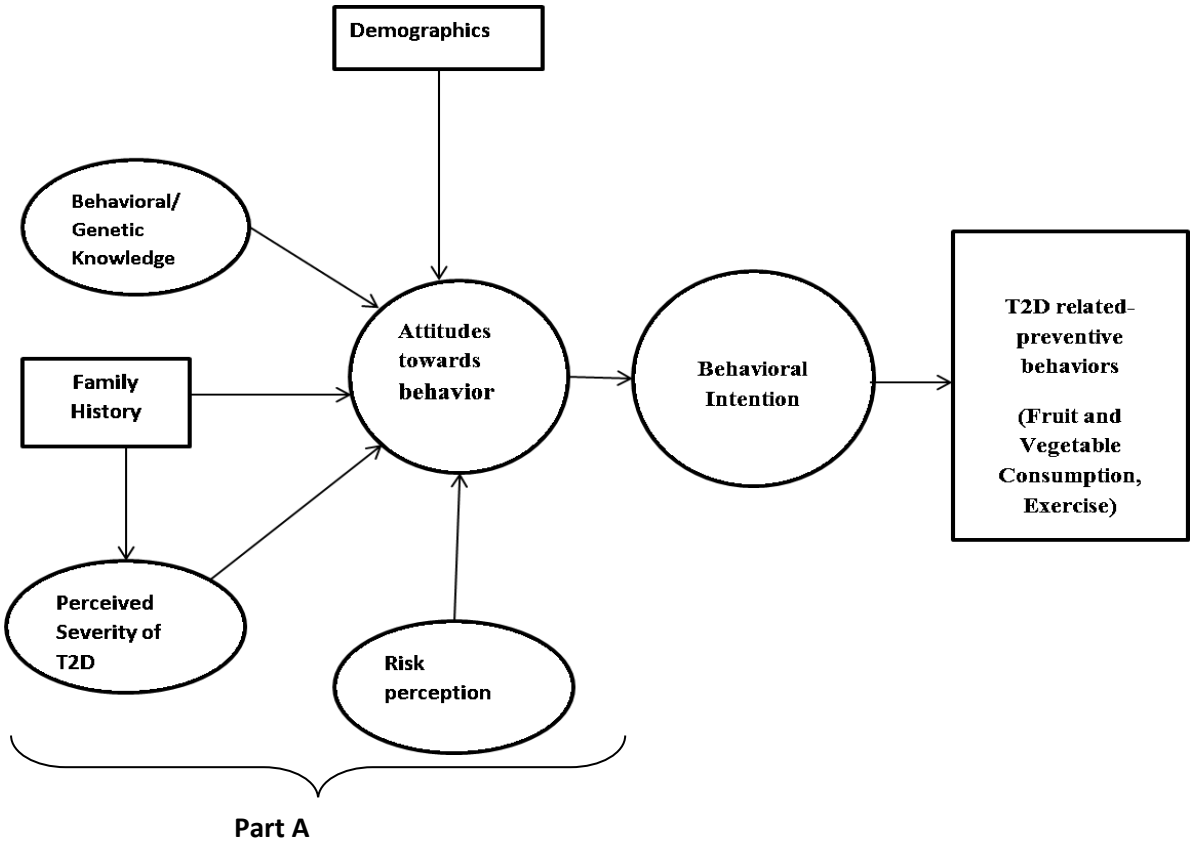

Figure 2: Conceptual Model for positive family history status (FH+) and Negative family history status (FH-)

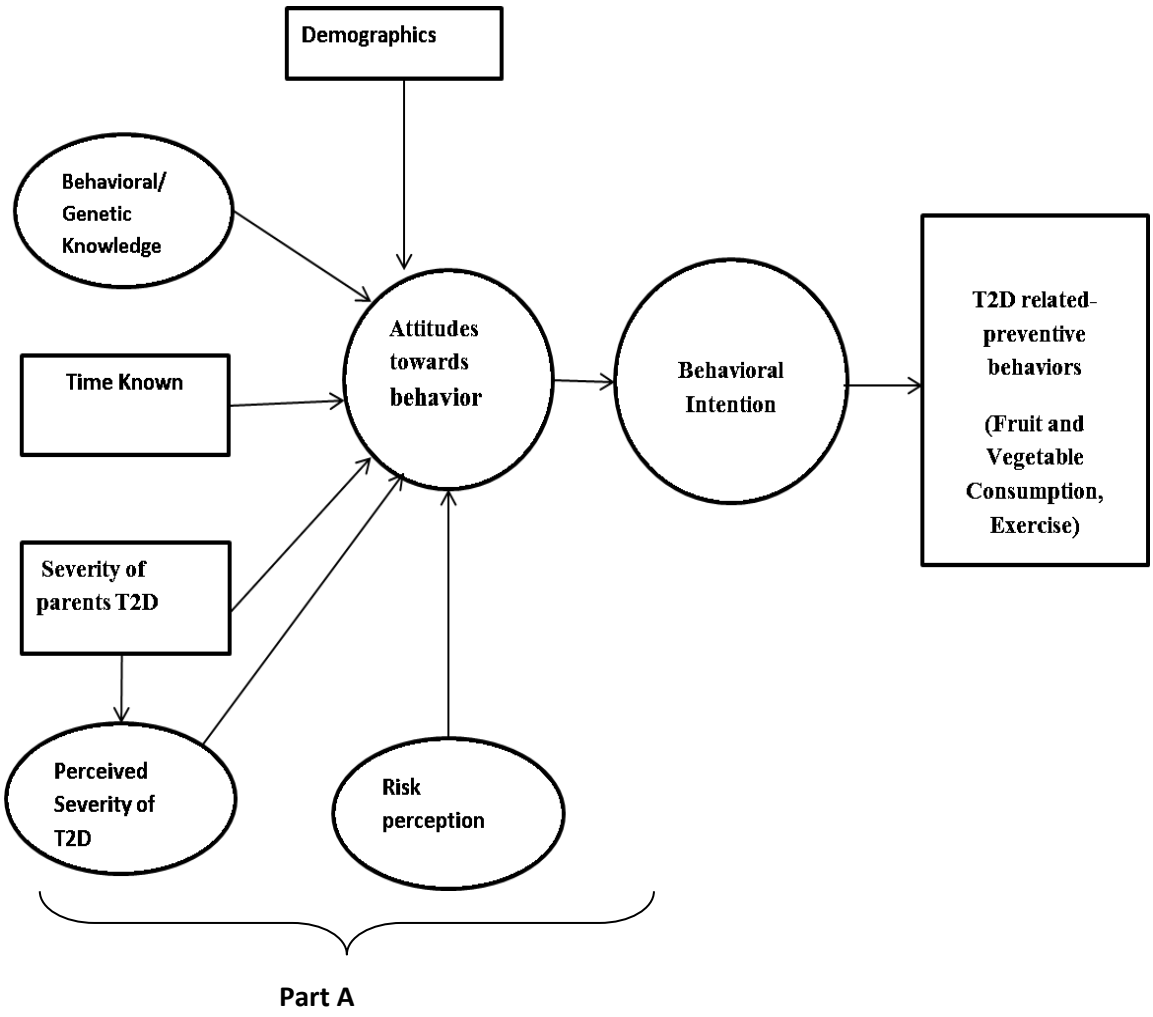

Figure 3 Conceptual Model for positive family history status (FH+) including FH-Severe and Time-Known

Methods

Sample Selection and Participants

Undergraduate students (18 or older) enrolled in four colleges/universities across a southern state were the participants in this study. Solicitations were sent to student's school emails via administrative academic advisors. Prior to participation, students were informed that the survey was completely voluntary and informed consent was provided. A minimum of 600 participants completed online surveys were needed for the use of the structural equation modelling technique to test the hypothesized conceptual model. A total of 7,600 students were contacted and 909 responded leading to a 12% response rate. The study was evaluated and approved by Institutional Review Boards in each respective institution. Data collection started on September 16th, 2014 and data analyses started January 16th, 2015. Incentives were provided in the form of $40 major-retailer gift cards to 13 participants via random drawing. Using monetary incentives has been shown to increase the likelihood of participation in online surveys and may improve the quality of participants' responses (Goritz, 2010).

The majority of the study participants were females (81.5%; n=736). Most of the respondents were Caucasian white (58.6%; n= 616) followed by Hispanic/Latino (n=145; 16.1) and Black/African American (n=74; 8.2%). The average age was 20 (S.D =1.36) years old.

Instrument and Measures

This present study used a cross-sectional survey design. Content validity of the survey instrument was established by two specific procedures. First, five experts in health education, research methods and nutrition reviewed the instrument items for relevance

and content coverage. After adequate instrument revisions were made, a purposive pilot sample of 17 first year undergraduate students participated in cognitive interviews to ensure that questions were understood. These responses were not included in the final analyses. For this present study, we examined questions specific to family history, demographic factors (age, biological sex, BMI, race and marital status), perceptions (risk and severity), behavioral intention, attitude, fruit and vegetable consumption and physical activity. See appendix for the instrument.

Demographic Characteristics: Participant characteristics were obtained and assessed using items related to biological sex, race/ethnicity, marital status, Body Mass Index (BMI) and age. Demographic questions were adapted from the American College Health Survey Questionnaire (American College Health Association, 2009).

T2D Knowledge: Knowledge of five known risk factors for T2D (family history, genes, being overweight, lack of exercise, lack of routine clinical screening) was assessed. The questions used to assess T2D knowledge were adapted from an instrument used by Baptiste-Roberts and Colleagues (2007) (Baptiste-Roberts et al., 2007) to assess knowledge of risk factors in African Americans. This measure utilized a four point Likert scale for which participants were asked to classify each risk factor of developing T2D as "I don't know" (coded as 0), "definitely does not decrease (coded as 1)," "probably does not decrease (coded as 2)," "probably decreases (coded as 3)," and "definitely decreases (coded as 4)". Responses to each of these items were added together to create a single, continuous and composite indicator of knowledge. Higher scores indicated that the participant was more knowledgeable about risk factors for T2D. The knowledge scales for the data exhibited good internal consistency ($\alpha = 0.78$) (Tavakol and Dennick, 2011).

Perceptions: Perception of T2D risk was adapted from a prior instrument (Nishigaki et al., 2007). We assessed risk perception by asking three questions: 1) "What do you think your chance is of developing Type 2 Diabetes in your lifetime?" Possible responses ranged from 1 to 10. Students were asked to choose a number between 0 (no chance of Type 2 Diabetes) and 10 (definitely will get Type 2 Diabetes); 2) "What is the chance of you getting Type 2 Diabetes compared with an average man/woman your age"? Possible responses were Much Lower (coded as 1), Slightly Lower (coded as 2), About the Same (coded as 3), Higher (coded as 4), and Much Higher (coded as 5); 3) "How likely do you think it is that you will develop Type 2 Diabetes during the next 5 years?" Students were asked to choose a number between 0 (no chance of Type 2 Diabetes) and 10 (definitely will get Type 2 Diabetes). These 3 items were combined to create a single continuous composite score for perceptions of T2D risk. The Cronbach's alpha for all 3 items was good ($\alpha = 0.74$) (Tavakol and Dennick, 2011).

Perceptions of T2D severity was also assessed by three items: 1) "I believe that Type 2 Diabetes is severe"; 2) "I believe that Type 2 Diabetes is serious" and 3) "I believe that Type 2 Diabetes is significant". All three questions had the same responses, Strongly Disagree (coded as 1), Disagree (coded as 2), Agree (coded as 3) and Strongly Agree (coded as 4). All three items measuring perceptions of T2D severity were combined to create a single continuous composite score. The internal consistency for all three items was very good ($\alpha = 0.85$) (Tavakol and Dennick, 2011).

Attitudes: Attitudes towards T2D related protective behaviors (physical activity and a healthy diet) were also assessed. Participants were asked to indicate the level on a scale of 1 to 10 in which they feel participating in regular exercise or eating healthy foods

regularly is Bad-Good, Unhealthy-Healthy, Unpleasant – Pleasant, Not Useful-Useful, Not beneficial - Beneficial and Unwise –Wise. The questions were adapted from the TPB questionnaire put forward by Azjen. For this data, the internal consistency for assessing students' attitudes eating towards healthy foods regularly was good ($\alpha = 0.84$), and for attitudes towards exercising regularly ($\alpha = 0.82$) (Tavakol and Dennick, 2011). We created a single composite and continuous 'attitude' variable for healthy diet and a different one for physical activity.

Behavioral Intention: To assess college students' intention to eat healthy foods such as fruits and vegetables or intention to exercise, we asked students to choose a number between 1 and 10 to indicate how strong their intention was. The item stated "In the next three months, I intend to: Eat healthy foods" and "In the next three months, I intend to: Exercise more". Internal consistency was good ($\alpha = 0.73$) (Tavakol, and Dennick, 2011). The questions were adapted from the TPB questionnaire put forward by Azjen (Ajzen, 2011).

Family history of T2D: Family history was assessed via the item: "Have any of your family members (mother, father, brother, sister, grandparents on both mothers and fathers side, aunts and uncles on both mothers and fathers side and cousins on both mothers and fathers side) ever been diagnosed with Type 2 Diabetes?" Possible responses were "No", "Yes", "I don't know" and "Not applicable". Responses were coded to create a dichotomous outcome variable for T2D family history status, such that "Yes" (coded 1) indicated a positive family history while "No", "I don't know" and "Not applicable" (coded 0) indicated a no family history of T2D. The question used to assess family history was adapted from the questionnaire originally used by Baptiste-Roberts and

Colleagues (2007) to assess family history of T2D in African Americans and was adapted to include extended family members.

Severity of Family Members' T2D: This item was created for the purpose of this study based on the indicators of severe cases of T2D. To survey actual severity of T2D in respondents' families, respondents were asked to "Please select if your family member or members with Type 2 Diabetes has experienced or is experiencing any of the following: Kidney disease, Heart disease, Blindness, Limb amputation or an Emergency room visit for a T2D related issue". Possible responses were "No", "Yes", and "I don't know". Responses were coded to create a dichotomous outcome variable for T2D family member severity status, such that "Yes" (coded 1) indicated that their family member had severe T2D "No", "I don't know" and "Not applicable" (coded 0) indicated that their family member did not have severe T2D.

Amount of Time Known about Family Members T2D Diagnosis: This item was created for the purpose of this study. We wanted to assess the amount of time the student had known about the family members T2D diagnosis as this may affect the attitude towards T2D related preventive behaviors. For example, someone whose father was diagnosed five years ago may have a different attitude towards preventing T2D than someone whose father was diagnosed one week ago. Participants were asked to state how long they had known about their family members' diagnosis in years or months. All responses were converted into months.

Vegetable Consumption: Vegetable consumption behaviors were measured by asking participants: "About how many cups of vegetables (including 100% pure vegetable juice) do you eat or drink each day? (1 cup of vegetables could be equal to: 3

broccoli spears, 1 cup cooked leafy greens, 2 cups lettuce or raw greens, 12 baby carrots, 1 medium potato, 1 large sweet potato,1 large ear of corn, 1 large raw tomato, 2 large celery sticks, 1 cup of cooked beans)." Possible responses for this question were "Never" (coded as 0), "1/2 cup or less" (Coded as 1), "1/2 cup to 1 cup" (Coded as 2) "1 to 2 cups" (coded as 3), "2 to 3 cups" (coded as 4), "3 to 4 cups" (coded as 5) and "4 or more cups" (coded as 6). This question was adapted from the Health Information National Trends Survey (Nelson et al., 2004).

Fruit Consumption: Fruit consumption behaviors were measured by asking participants: About how many cups of fruit (including 100% pure fruit juice) do you eat or drink each day? (1 cup of fruit could be equal to: 1 small apple, 1 large banana, 1 large orange, 8 large strawberries, 1 medium pear, 2 large plums, 32 seedless grapes, 1 cup (8 oz.) fruit juice, ½ cup dried fruit, 1 inch-thick wedge of watermelon). Possible responses for this question were "Never" (coded as 0), "1/2 cup or less" (Coded as 1), "1/2 cup to 1 cup" (Coded as 2) "1 to 2 cups" (coded as 3), "2 to 3 cups" (coded as 4), "3 to 4 cups" (coded as 5) and "4 or more cups" (coded as 6). This question was adapted from the Health Information National Trends Survey (Nelson et al., 2004)

Combined Fruits and Vegetables Consumption: Responses to the aforementioned questions regarding fruits and vegetable consumption were multiplied to create a single, composite indicator of fruit and vegetable consumption. For instance, if a respondent indicated they typically ate 4 or more cups of vegetables each day (6 points), and consumed 1 -2 cups of fruit on average each day (3 points), then their composite fruits and vegetable consumption score would be 18 (6 x 3). Higher scores indicate more daily

consumption of fruits and vegetables. Cronbach's alpha was = 0.70 for the composite measure of fruits and vegetable consumption.

Physical Activity Behavior: Questions regarding the duration and frequency of physical activity were assessed via two items: (1) "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". 0 days (coded as 0), 1 day (coded as 1), 2 days (coded as 2), 3 days (coded as 3), 4 days (coded as 4), 5 days (coded as 5), 6 days (coded as 6) and 7 days (coded as 7); and (2) "How much time in total did you usually spend on one of those days doing moderate physical activities?" Possible responses were open ended and participants were prompted to write the length of time in a box provided. All responses were in minutes. Responses to each of these items were multiplied to create a single, composite indicator of physical activity. For instance, if a respondent indicated they were at least moderately active 3 days a week, and they typically engaged in such activity for 40 minutes, then their weekly physical activity would be 120 minutes. Higher scores indicated higher levels of physical activity each week. This question was adapted from the Health Information National Trends Survey (Nelson et al., 2004).

Data Analysis

The proposed conceptual model was examined through structural equation modeling (SEM) techniques because of SEM's ability to examine the suitability of conceptual models. Model fit was evaluated with Chi-square test. However, because this test was very sensitive to sample size, other model fit indices such as the SRMR (Standardized Root Mean Square Residual) and RMSEA (Root Mean Square Error of

Approximation) were also evaluated (Fan, Thompson, & Wang, 1999). Direct and indirect effects were also analyzed. All analyses were run in MPLUS Statistics 7.0 and SPSS 22.0. Missing values were deleted list wise from the analyses. Students who identified as adopted (n=4) were excluded from the analyses leading to a final sample size of 905. After missing data were deleted list wise the total sample size was 903.

We performed a group by group analysis for participants with and without a family history of T2D using the exact variables to be able to compare across both groups. We then excluded those without a family history of T2D from the analysis to include the other variables specific to having a positive family history of T2D such as severity of family members T2D and average time the students have known about their family members T2D diagnosis. Therefore, a total of four models based on the primary behavior were examined:

- ***Model 1***: Group analysis by family history of T2D status and F&V consumption behavior.
- ***Model 2*:** Positive family history of T2D with severity of family members T2D and average time the students have known about their family members T2D and F&V consumption behavior.
- ***Model 3*:** Group analysis by family history of T2D status and physical activity behavior.
- ***Model 4***: Positive family history of T2D with severity of family members T2D and average time the students have known about their family members T2D and physical activity behavior.

Results

Descriptive Statistics of Key Variables

Participants were undergraduate students (18 or older) enrolled full time or part-time in four colleges/universities across a large southwestern state. The sample consisted of a majority of females (81.5%; n=736). Most of the respondents were White (68.2%; n= 616) and the average age was 20 years old. Participants who had a family member diagnosed with T2D were (48.8%; n=441) while those without a family member diagnosed with T2D were (51.2%; n=462). Calculated Body Mass Index (BMI) from the self-reported height and weight data showed that about 3% were underweight, 61% were normal weight, 22% overweight, and 14% were obese.

The majority of participants (81.4%; n=736) consumed between ½ to 2 cups of vegetables per day and most of the participants (90.1%; n=818) consumed ½ to 3 cups of fruits per day. On average, respondents engaged in 289.64 minutes (SD=577.04) of physical activity per week. Participants with a positive T2D family history were (48.8%; n=441) while those with a negative T2D family history were (51.2%; n=462). See Table 1 for more demographic details.

Model 1

The proposed model resulted in a χ^2 of 115.85 (n = 903, df = 50, p = 0.009). More fit indices yielded an SRMR = .033 and RMSEA = .054. Together, these results (the $\chi 2$, SRMR and RMSEA) suggested the model fit the data moderately. The proposed model was then modified, after examining regression weights and modification indices (3.84) by regressing risk perception on F&V consumption, behavioral intention on BMI, F&V consumption on White, and F&V consumption on age. The modified model resulted in a

reduced $\chi 2$ of 51.32 (N = 903, DF = 42, p = 0.153). Other fit indices yielded an SRMR = 0.019 and RMSEA = 0.022. Together, these results (the $\chi 2$, SRMR and RMSEA) suggested the model was improved and fit the data very well. For those with a negative T2D family history, the significant paths to attitudes were biological sex (β=.25), age (β=.96), Asian (β=-5.98), PIAA, T2D knowledge and perceived T2D severity. Attitude significantly predicted Intention and Intention significantly predicted F&V consumption ($p<0.05$). Figure 4 and figure 6 shows all paths. Other direct significant paths to F&V consumption were being White and risk perception ($p<0.05$) (See Figure 5). For those with a positive T2D family history, the significant paths to attitudes were only being Black and T2D knowledge ($p<0.05$). Attitude significantly predicted Intention and Intention significantly predicted F&V consumption. Other direct significant paths to F&V consumption were being White, age and risk perception ($p<0.05$) (See Figure 7).

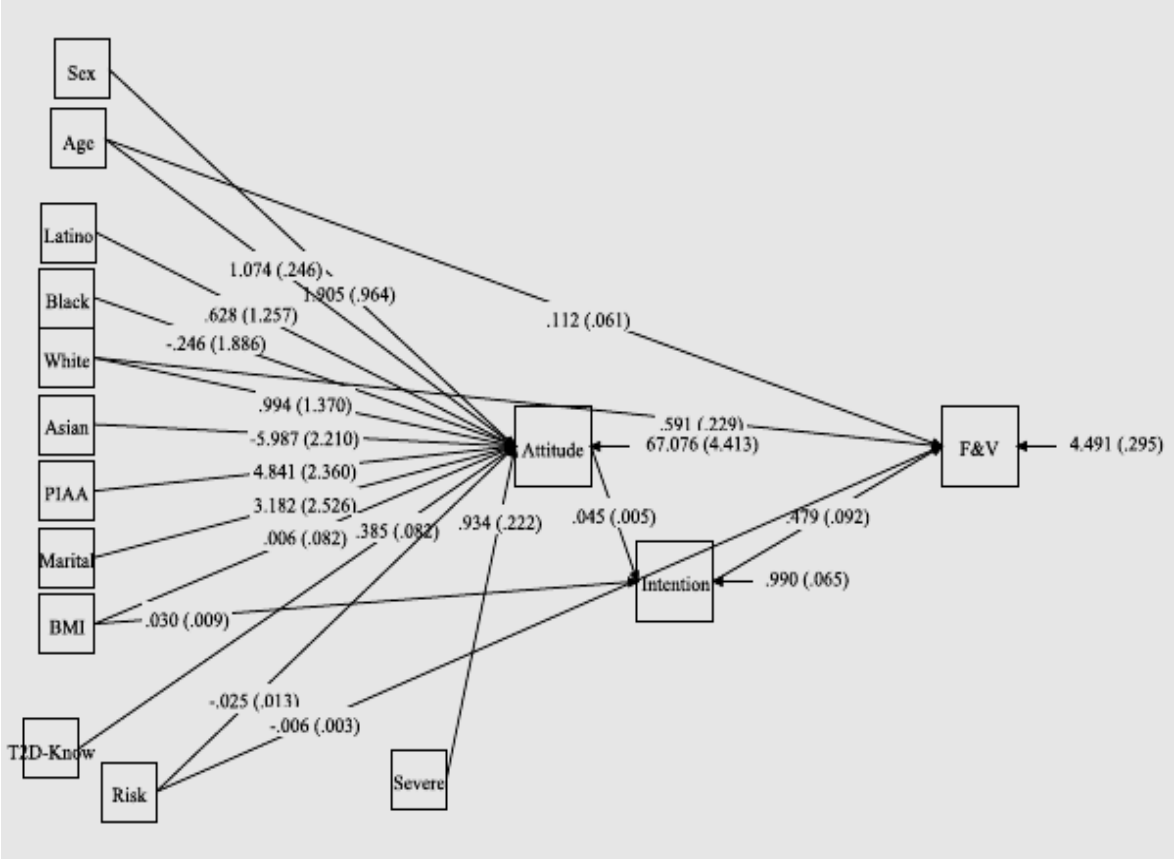

Figure 4: Conceptual Model for F&V FH- (All Paths)

NOTE: *PIAA*=Pacific Islander/Alaskan Native; *BMI*=Body Mass Index; *T2D-Know*=Total knowledge about T2D; *Risk*=T2D Risk Perception; *Severe*= Perceived T2D Severity; *Attitude*=Attitude towards eating healthy foods; *Intention*=Intention to eat healthy foods; *F&V*=Fruits and Vegetable

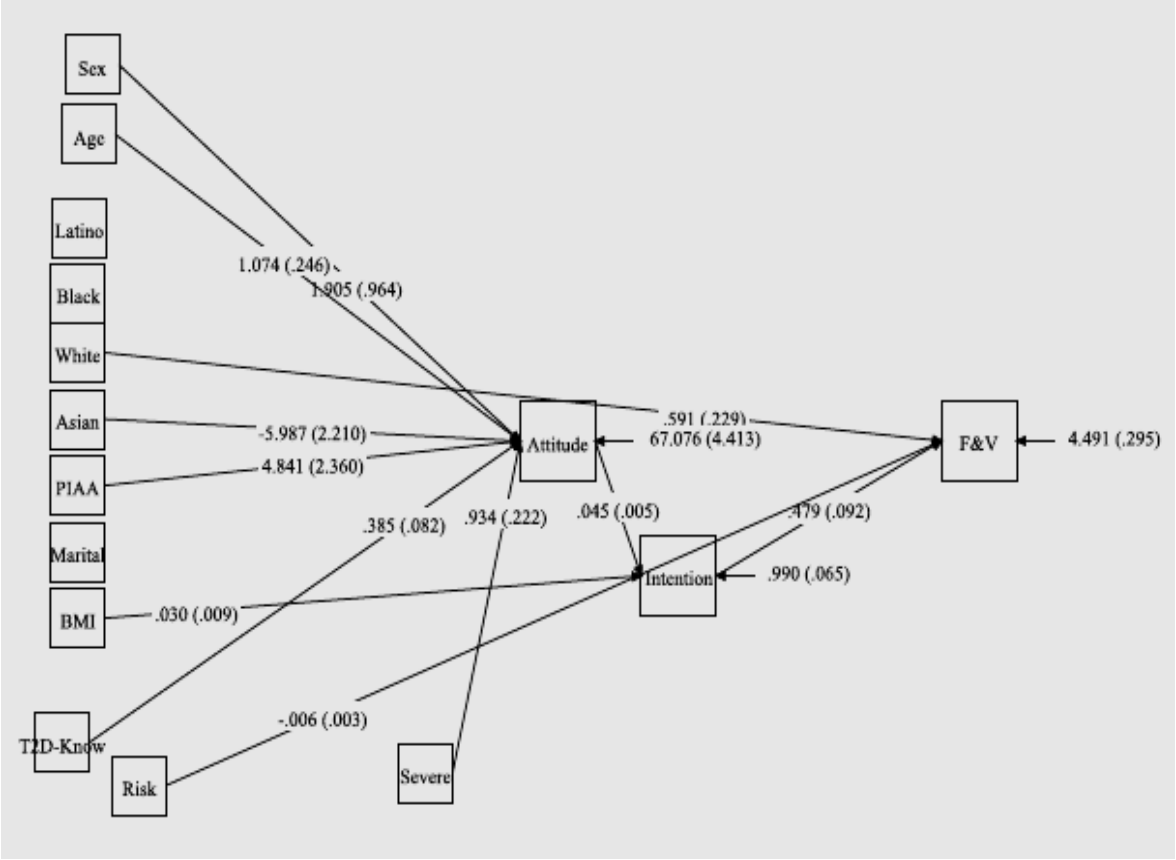

Figure 5: Conceptual Model for F&V FH- (Significant Paths)

NOTE: *PIAA*=Pacific Islander/Alaskan Native; *BMI*=Body Mass Index; *T2D-Know*=Total knowledge about T2D; *Risk*=T2D Risk Perception; *Severe*= Perceived T2D Severity; *Attitude*=Attitude towards eating healthy foods; *Intention*=Intention to eat healthy foods; *F&V*=Fruits and Vegetable.

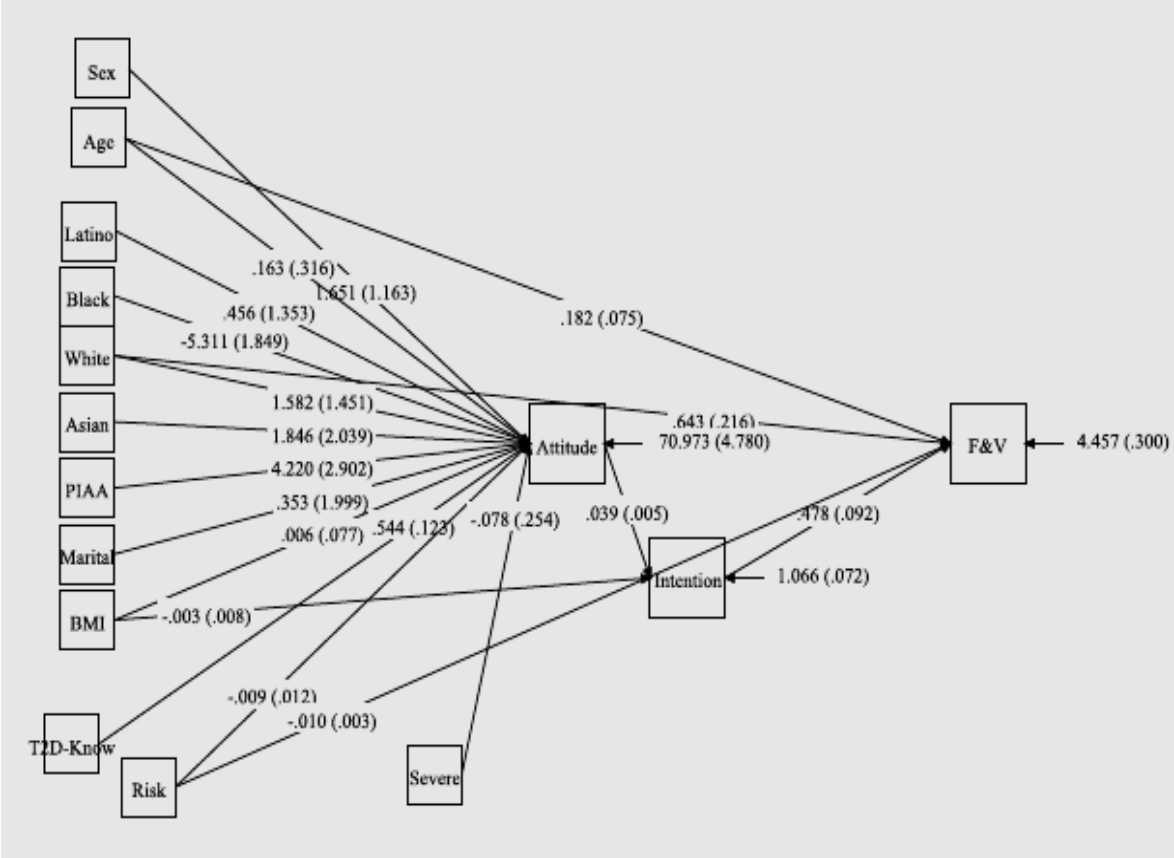

Figure 6: Conceptual Model for F&V FH+ (All Paths)

NOTE: *PIAA*=Pacific Islander/Alaskan Native; *BMI*=Body Mass Index; *T2D-Know*=Total knowledge about T2D; *Risk*=T2D Risk Perception; *Severe*= Perceived T2D Severity; *Attitude*=Attitude towards eating healthy foods; *Intention*=Intention to eat healthy foods; *F&V*=Fruits and Vegetable.

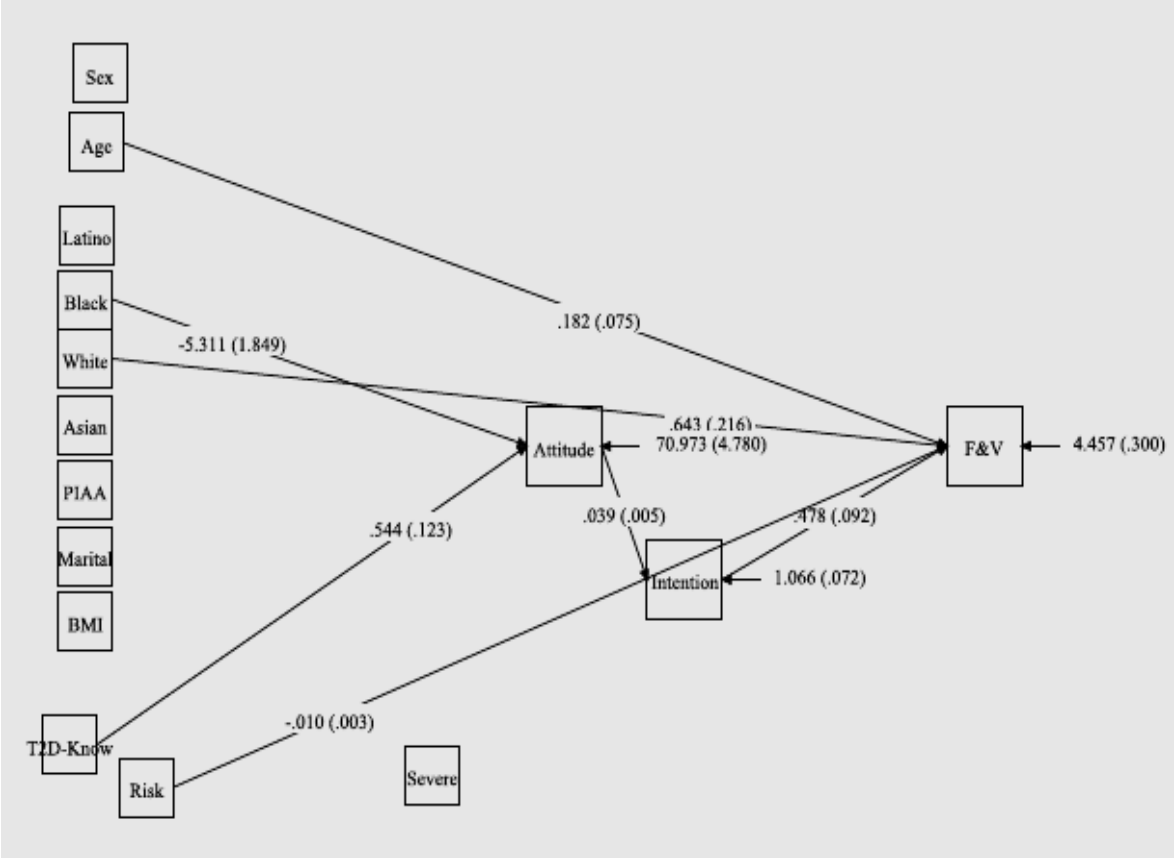

Figure 7: Conceptual Model for F&V FH+ (Significant Paths)

NOTE: *PIAA*=Pacific Islander/Alaskan Native; *BMI*=Body Mass Index; *T2D-Know*=Total knowledge about T2D; *Risk*=T2D Risk Perception; *Severe*= Perceived T2D Severity; *Attitude*=Attitude towards eating healthy foods; *Intention*=Intention to eat healthy foods; *F&V*=Fruits and Vegetable.

Model 2

The proposed model included severity of relatives T2D and the amount of time students have known about their relatives T2D diagnosis. Fit indices resulted in a $\chi 2$ of 109 (n = 441, df = 52, p = 0.000), indicating that the model was not a good fit. Further fit indices produced an SRMR = 0.042 and RMSEA = .050. Together, these results (the $\chi 2$, SRMR and RMSEA) suggested the model did not fit the data adequately. The proposed model was then modified, after examining regression weights and modification indices (3.84), F&V consumption on White, and F&V consumption on age. The modified model then resulted in a reduced $\chi 2$ of 86.46 (n = 441, df = 50, p = 0.85). Other fit indices yielded a SRMR = .034 and RMSEA = 0.041. Together, these results (the $\chi 2$, SRMR and RMSEA) suggested an improved and good model fit. The significant paths to attitudes were only being Black, the amount of time a student has known about their relatives T2D diagnosis and T2D knowledge ($p<0.05$). Figure 8 shows all paths. Attitude significantly predicted behavioral Intention and behavioral Intention significantly predicted F&V consumption ($p<0.05$). Family members T2D severity significantly predicted student's perceived T2D severity ($p<0.05$). Other direct significant paths to F&V consumption were being White and age ($p<0.05$) (See Figure 9).

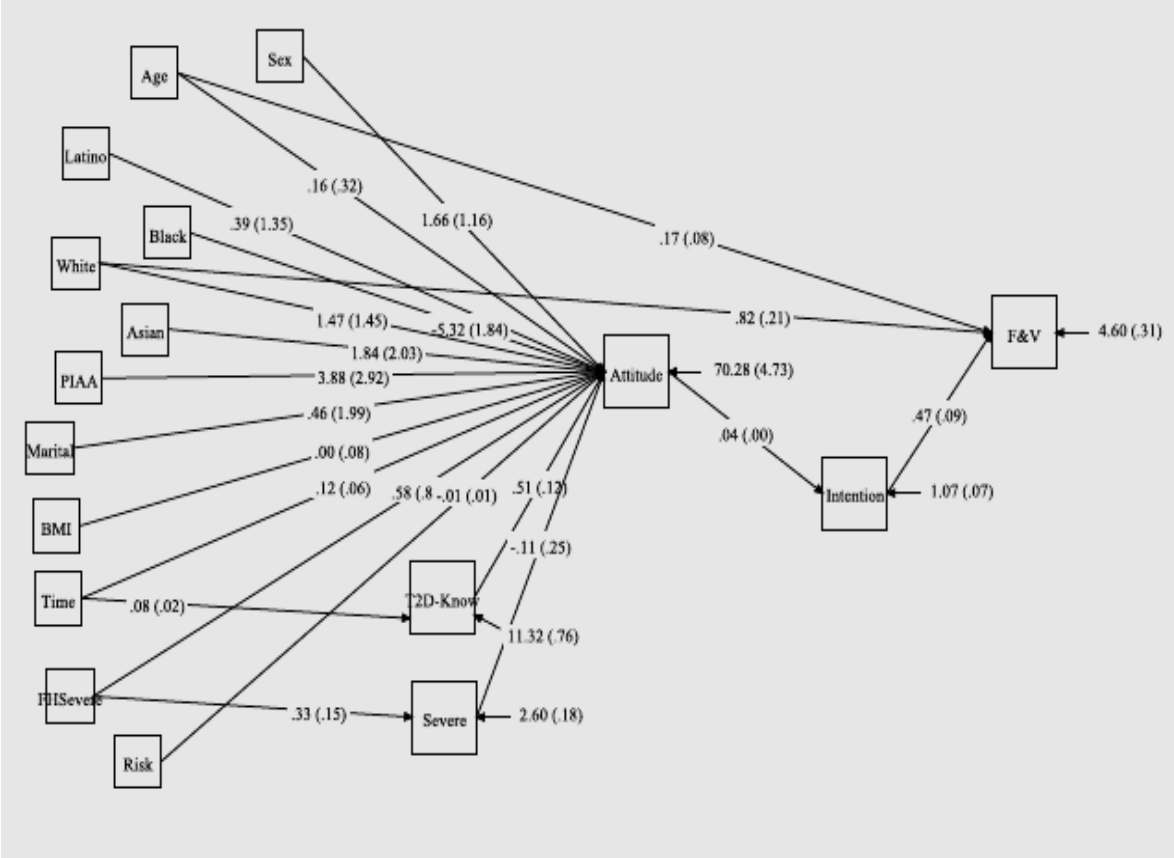

Figure 8: Conceptual Model including FH-Severe and Time-Known for FH+ (All Paths)

NOTE: *PIAA*=Pacific Islander/Alaskan Native; *BMI*=Body Mass Index; *T2D-Know*=Total knowledge about T2D; *Risk*=T2D Risk Perception; *Severe*= Perceived T2D Severity; *FHSevere*= Severity of a relatives T2D; Time=Amount of time known about relatives T2D diagnosis; *Attitude*=Attitude towards eating healthy foods; *Intention*=Intention to eat healthy foods; *F&V*=Fruits and Vegetable.

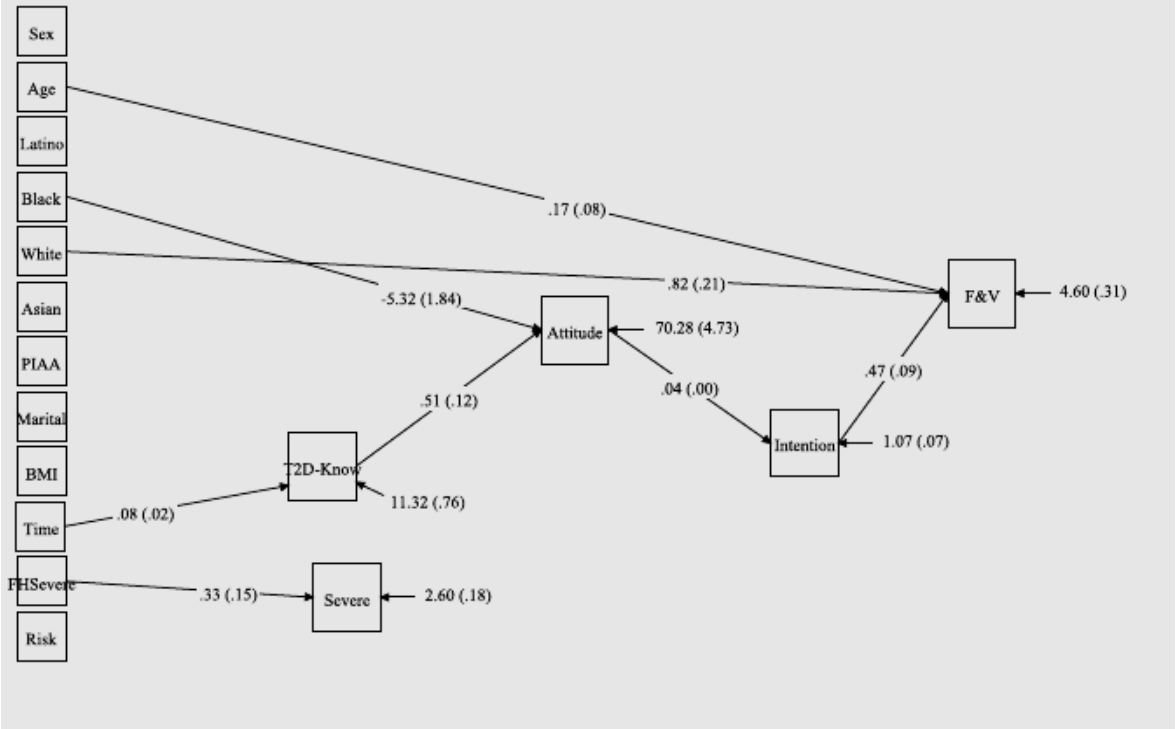

Figure 9: Conceptual Model including FH-Severe and Time-Known for FH+ (Significant Paths)

NOTE: *PIAA*=Pacific Islander/Alaskan Native; *BMI*=Body Mass Index; *T2D-Know*=Total knowledge about T2D; *Risk*=T2D Risk Perception; *Severe*= Perceived T2D Severity; *FHSevere*= Severity of a relatives T2D; Time=Amount of time known about relatives T2D diagnosis; *Attitude*=Attitude towards eating healthy foods; *Intention*=Intention to eat healthy foods; *F&V*=Fruits and Vegetable.

Model 3

The proposed model resulted in a $\chi 2$ of 115.85 (n = 903, df = 50, p = 0.002). More fit indices yielded an SRMR = .026 and RMSEA = .039. Taken together, these results (the $\chi 2$, SRMR and RMSEA) suggested the model fit the data moderately. The proposed model was then modified, after examining regression weights and modification indices (3.84) by correlating behavioral intention and attitude. The modified model resulted in a $\chi 2$ of 63.12 (n = 903, df = 48, p = 0.07). Other fit indices yielded an SRMR = .021 and RMSEA =.026. Together, these results (the $\chi 2$, SRMR and RMSEA) suggested the model fit the data very well. For those with a negative T2D family history, the significant paths to attitudes were biological sex, age, Asian, PIAA, T2D knowledge and perceived T2D severity. Attitude significantly predicted Intention ($p<0.05$), however, Intention did not significantly predict physical activity behavior ($p>0.05$) (See Figure 11). For those with a positive T2D family history, the significant paths to attitudes were only being black and T2D knowledge ($p<0.05$). Attitude significantly predicted Intention ($p<0.05$). Intention did not significantly predict physical activity behavior ($p>0.05$) (See Figure 13). Figure 10 and figure 12 show all paths.

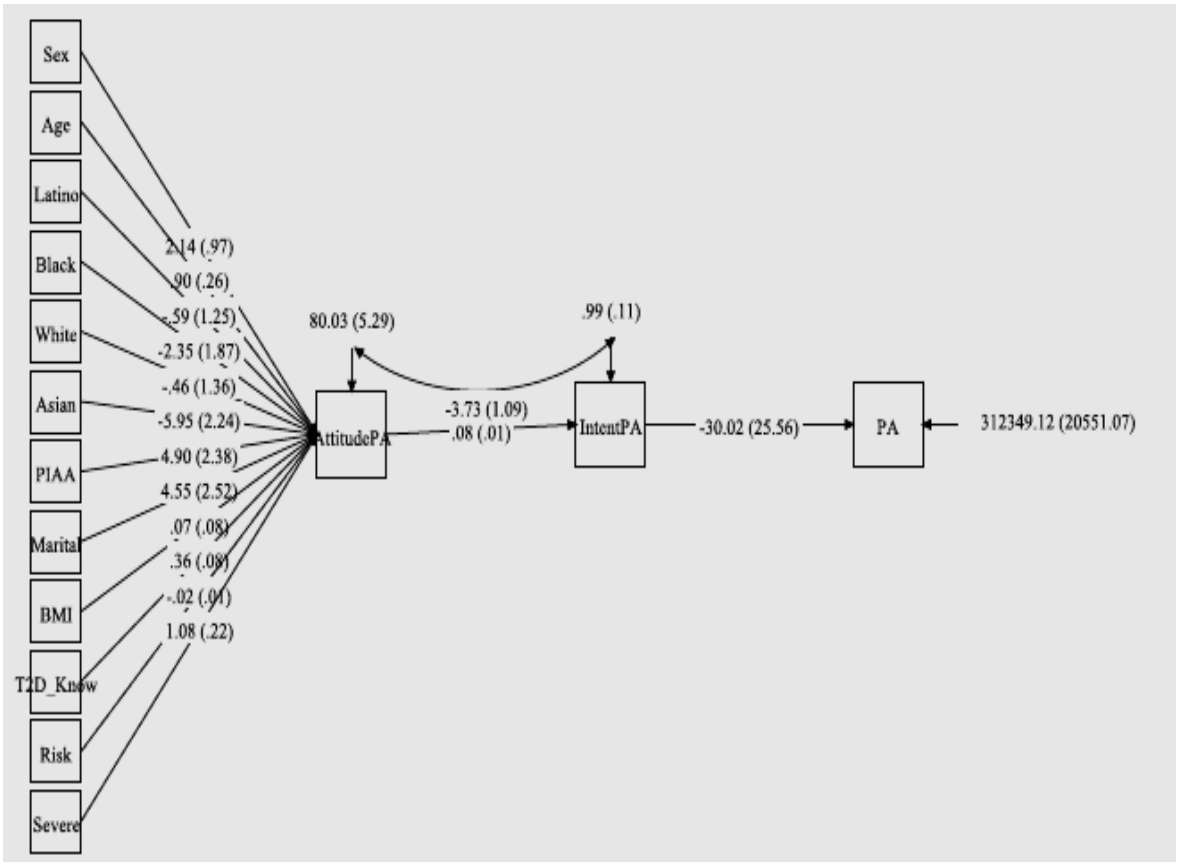

Figure 10: Conceptual Model for PA FH- (All Paths)

NOTE: *PIAA*=Pacific Islander/Alaskan Native; *BMI*=Body Mass Index; *T2D-Know*=Total knowledge about T2D; *Risk*=T2D Risk Perception; *Severe*= Perceived T2D Severity; A*ttitudePA*=Attitude towards engaging in PA; *IntentPA*=Intention to engage in PA; *PA* =Physical Activity.

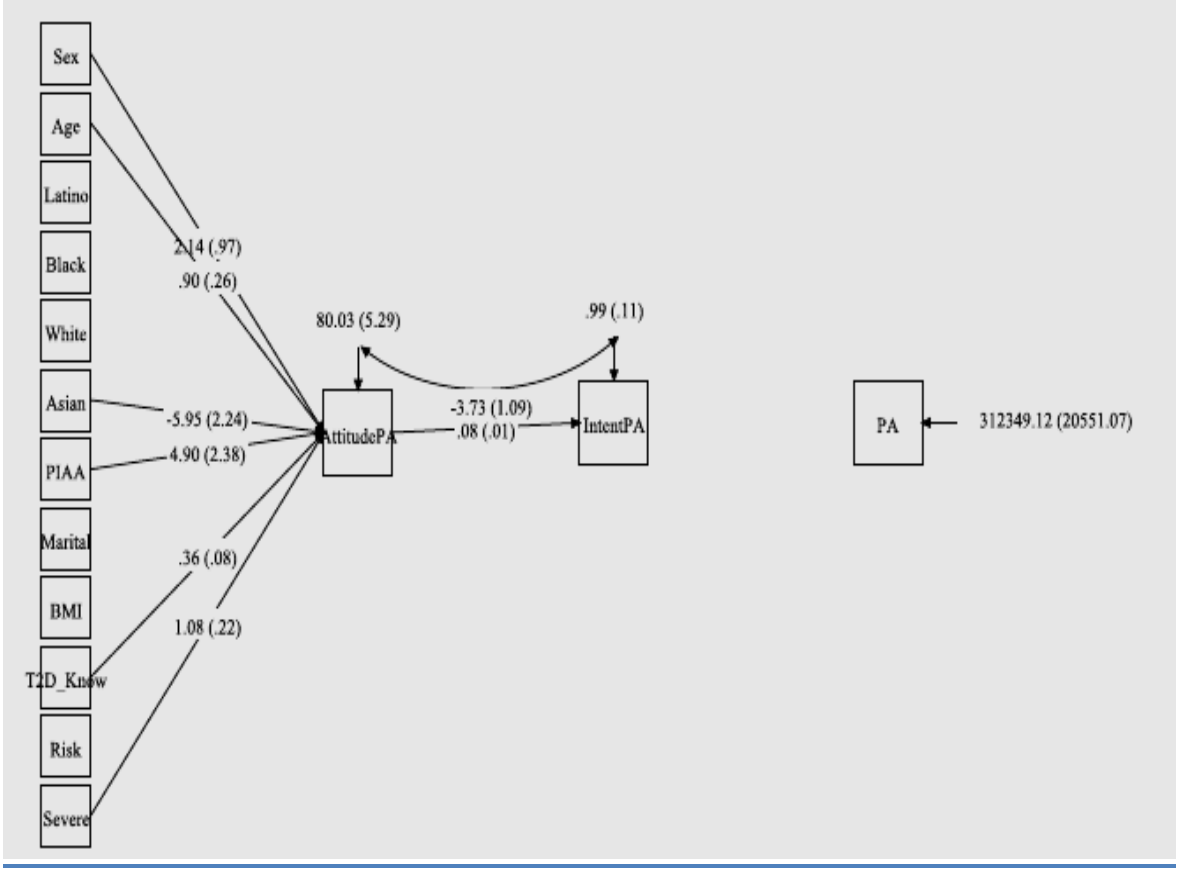

Figure 11: Conceptual Model for PA FH- (Significant Paths)

NOTE: *PIAA*=Pacific Islander/Alaskan Native; *BMI*=Body Mass Index; *T2D-Know*=Total knowledge about T2D; *Risk*=T2D Risk Perception; *Severe*= Perceived T2D Severity; A*ttitudePA*=Attitude towards engaging in PA; *IntentPA*=Intention to engage in PA; *PA* =Physical Activity.

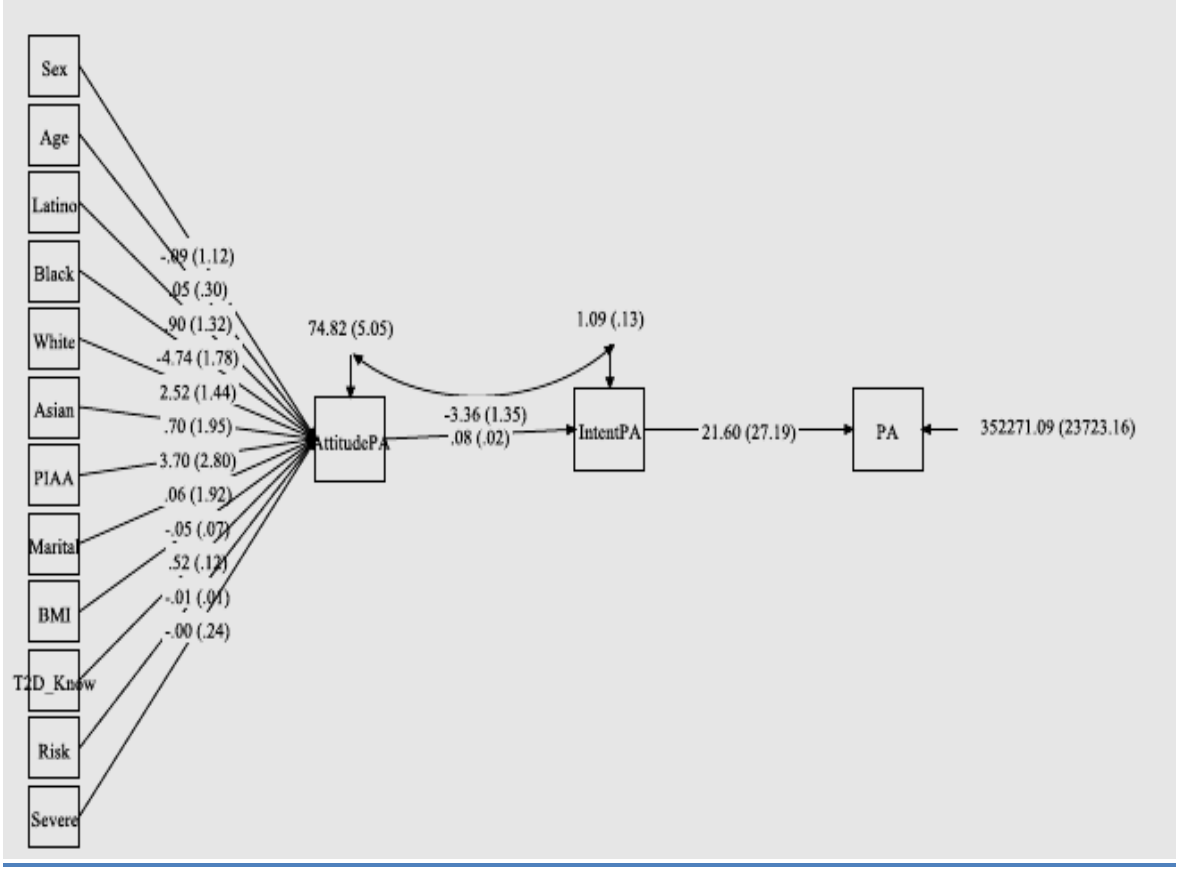

Figure 12: Conceptual Model for PA FH+ (All Paths)

NOTE: *PIAA*=Pacific Islander/Alaskan Native; *BMI*=Body Mass Index; *T2D-Know*=Total knowledge about T2D; *Risk*=T2D Risk Perception; *Severe*= Perceived T2D Severity; A*ttitudePA*=Attitude towards engaging in PA; *IntentPA*=Intention to engage in PA; *PA* =Physical Activity.

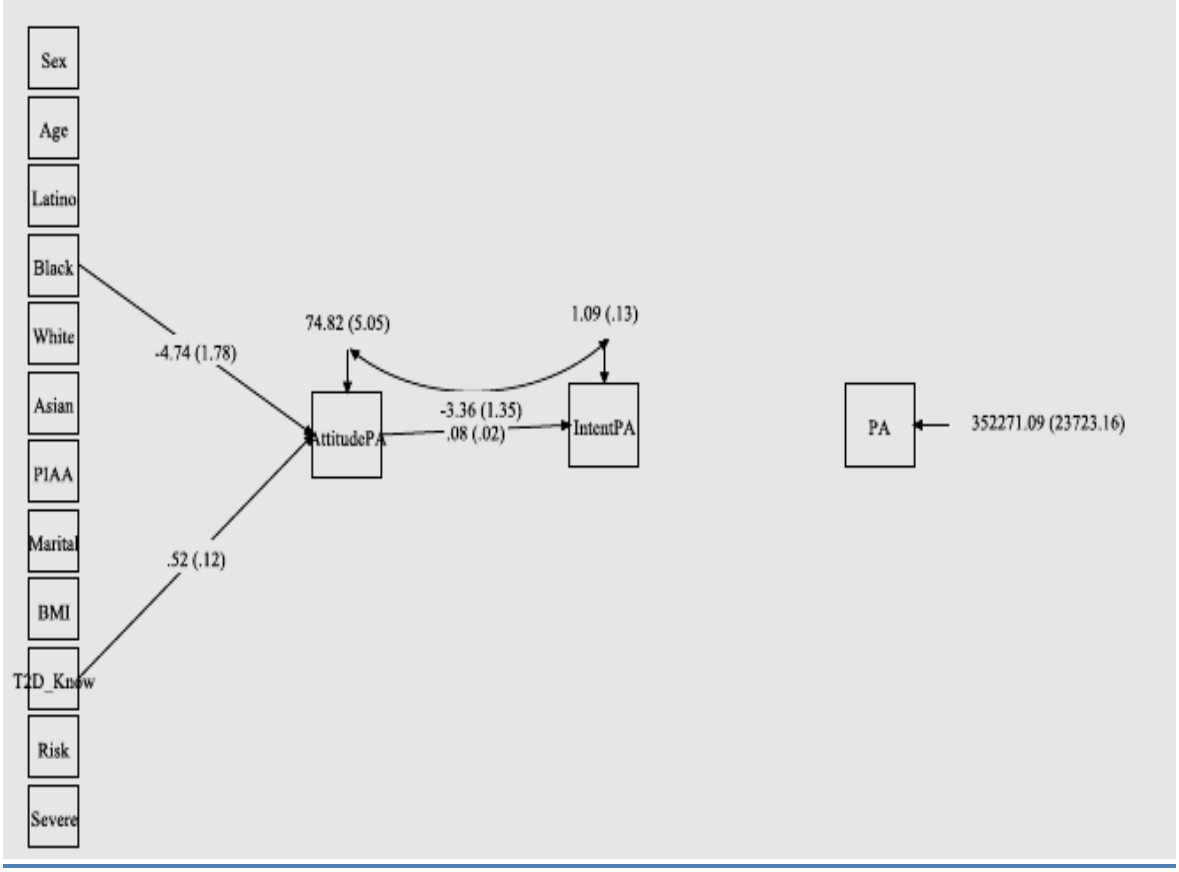

Figure 13: Conceptual Model for PA FH+ (Significant Paths)

NOTE: PIAA=Pacific Islander/Alaskan Native; BMI=Body Mass Index; T2D-Know=Total knowledge about T2D; Risk=T2D Risk Perception; Severe= Perceived T2D Severity; AttitudePA=Attitude towards engaging in PA; IntentPA=Intention to engage in PA; PA =Physical Activity.

Model 4

The proposed model included severity of parents T2D and the amount of time students have known about their relatives T2D diagnosis. Fit indices resulted in a $\chi 2$ of 212.99 (n = 441, df = 60, p = 0.000), indicating that the model was not a good fit. Further

fit indices produced an SRMR = 0.056 and RMSEA = .074. Together, these results (the $\chi 2$, SRMR and RMSEA) showed that the model was a very poor fit. The proposed model was then modified, after examining regression weights and modification indices (3.84). The model was modified by correlated BMI with risk perception and T2D with age. The model then resulted in a reduced $\chi 2$ of 138.12 ($n = 441$, $df = 70$, $p = 0.000$). Other fit indices yielded an SRMR = .048 and RMSEA = 0.047. Together, these results (the $\chi 2$, SRMR and RMSEA) suggested an average model fit. Figure 14 shows all paths. The significant paths to attitudes were only being White, the amount of time a student has known about their relatives T2D diagnosis and T2D knowledge ($p<0.05$). Attitude significantly predicted behavioral Intention ($p<0.05$) but behavioral Intention did not significantly predict physical activity ($p<0.05$). Family members T2D severity significantly predicted student's perceived T2D severity ($p<0.05$) (See Figure 15).

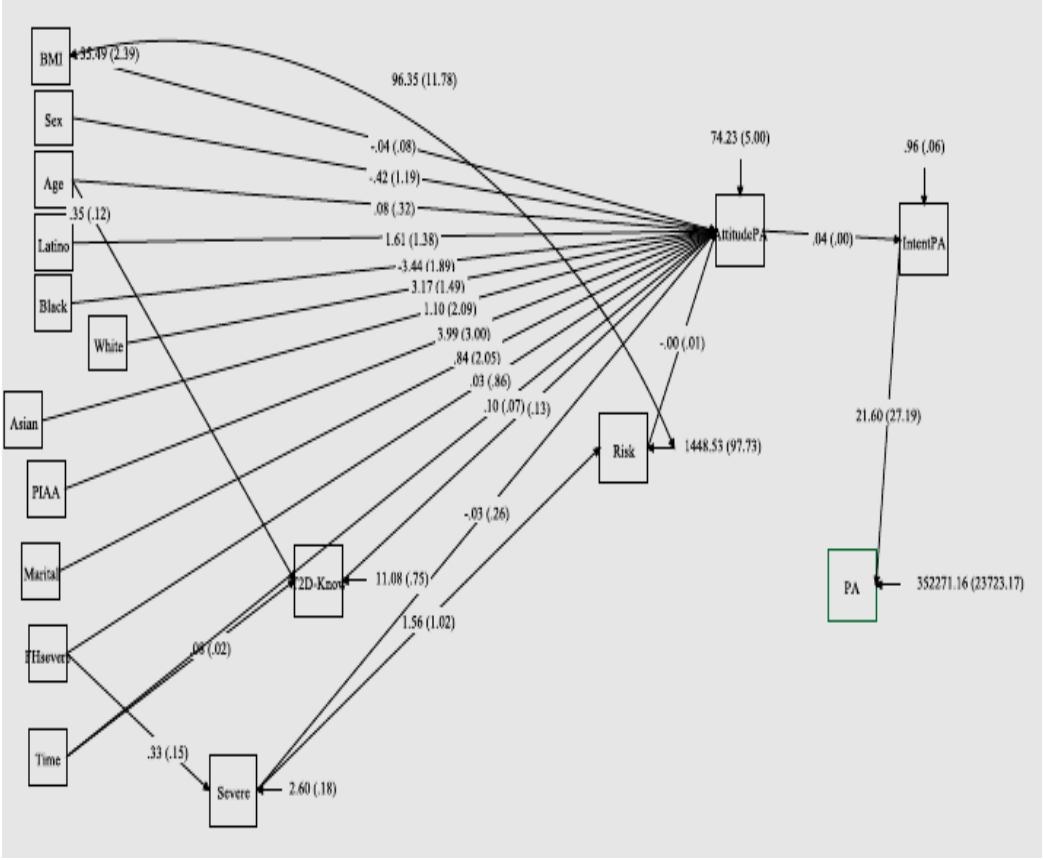

Figure 14: Conceptual Model including FHSevere and Time-Known for FH+ (All Paths)

NOTE: PIAA=Pacific Islander/Alaskan Native; BMI=Body Mass Index; T2D-Know=Total knowledge about T2D; Risk=T2D Risk Perception; Severe= Perceived T2D Severity; FHSevere= Severity of a relatives T2D; Time=Amount of time known about relatives T2D diagnosis; AttitudePA=Attitude towards engaging in PA; Intention=IntentPA to engage in PA; PA =Physical Activity.

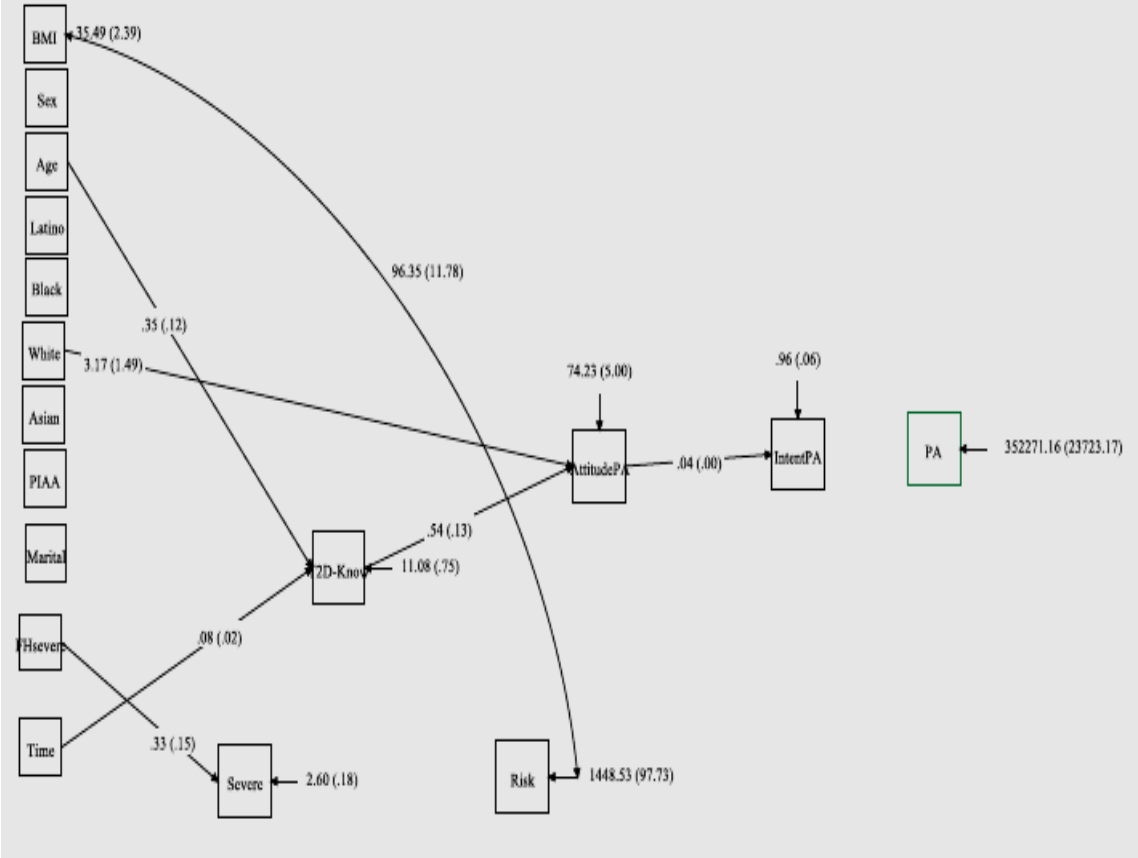

Figure 15**:** Conceptual Model including FHSevere and Time-Known for FH+ (Significant Paths)

NOTE: PIAA=Pacific Islander/Alaskan Native; BMI=Body Mass Index; T2D-Know=Total knowledge about T2D; Risk=T2D Risk Perception; Severe= Perceived T2D Severity; FHSevere= Severity of a relatives T2D; Time=Amount of time known about relatives T2D diagnosis; AttitudePA=Attitude towards engaging in PA; Intention=IntentPA to engage in PA; PA =Physical Activity.

Discussion

An understanding of the processes or paths that lead to T2D related preventive behaviors, such as physical activity and F&V consumption, could be used to design and implement more effective health intervention programs for young adults – a group that is at very high risk for engaging in unhealthy behaviors (American College Health Association, 2013). To achieve a greater understanding of paths leading to regular physical activity and regular F&V consumption among young adults with and without a family history of T2D, this study used cross-sectional data to test a conceptual model derived from the Health Belief Model (HBM) and Theory of Planned Behavior (TPB) constructs. The study was able to examine the network of interaction between variables and examine their influence on T2D related preventive behaviors (F&V consumption and exercise). Each scale used in the analyses demonstrated good internal consistency (Tavakol and Dennick, 2011).

Fruits and Vegetable Consumption

Relationships within the conceptual model showed that direct predictors of F&V consumption for college students with and without a family history of T2D were age, being White, T2D risk perception and behavioral intention. Consistent with our findings, other studies have found that Whites, compared to other races, are more likely to consume F&V (Dubowitz et al., 2008). Additionally, other studies have reported that behavioral intention influences F&V consumption (Bogers, Brug, van Assema, & Dagnelie, 2004; Lien, Lytle, & Komro, 2002; Shaikh, Yaroch, Nebeling, Yeh, & Resnicow, 2008). Interestingly, we also found that risk perception directly influenced F&V consumption, so the higher risk perception towards T2D prompted higher F&V

consumption. Consistent with other studies, risk perception of various diseases has been found to influence dietary behaviors. For example, one study found that people with lower risk perceptions of getting a disease consumed considerably less health enhancing foods such as F&V than those with higher risk perceptions (Zlot, Cox, Silvey, & Leman, 2012).

While students' age, being White, T2D risk perception and behavioral intention were the direct predictors of F&V consumption irrespective of T2D family history status, there were some indirect significant pathways observed, and these pathways differed based on T2D family history status. For the students with a positive family history, higher T2D knowledge was associated with positive attitudes, being Black was negatively associated with attitude, and attitude was positively associated with behavioral intention. For those with a negative family history, T2D knowledge, age, sex, being a Pacific Islander and perceptions of T2D severity were positively associated with attitudes, while being Asian was negatively associated with attitudes. Attitude and BMI were significantly associated with behavioral intention. A salient finding from these results is that Intervention efforts and programs targeted at reducing T2D epidemic through promoting F&V consumption may be tailored to individuals based on T2D family history status. This is because, based on the conceptual model we tested, individuals with a positive and negative T2D family history status seem to be influenced to consume F&V via different mechanisms.

Physical Activity

Relationships within the conceptual model showed that there were no direct predictors of physical activity for college students irrespective of their T2D family

history status even after modification indices were applied. This result runs counter to several studies that have shown strong relationships between behavioral intention and physical activity behavior (Gallagher & Updegraff, 2012; Prestwich et al., 2012; Sallis, Prochaska, & Taylor, 2000). However, contrary to these results, there is scientific evidence that postulates a gap between intention and physical activity behavior. This gap could be a topic that can be considered for contemporary research on predictors of physical activity, given that most of the health behavior models (e.g. theory of planned behavior) used to understand physical activity proposes that behavioral intention is the proximal precursor of behavior. The results should be useful as researchers develop new models and interventions to address intention–behavior discordance in the physical activity domain. A meta-analysis of 10 studies showed that about 36% of many people do not translate their intentions into physical activity (Rhodes & Bruijn, 2013). This finding yields important information, because traditional intention-based theories suggest that changing intention is the primary intervention target (Fishbein & Ajzen, 2005). The results suggest that, while some people still require interventions changing intentions, much of the inactive population has positive intentions.

While there were no direct predictors of physical activity behavior irrespective of T2D family history status, there were many indirect significant pathways observed and these pathways differed based on T2D family history status. For the students with a positive family history, higher T2D knowledge was associated with positive attitudes, being Black was negatively associated with attitude, and attitude towards exercising was positively associated with intention to exercise. For those with a negative family history, T2D knowledge, perceived severity of T2D, age, sex, being a Pacific Islander and Asian

were significantly associated with attitudes. Attitude was significantly associated with behavioral intention. Although none of the parts led to physical activity behavior even after modification indices were applied. It is very important to note that these results show varying mechanisms that lead to exercise intention based on having either a positive or negative T2D family history status.

Time Known and Relatives' T2D Severity

We included two more variables into the conceptual models for both F&V consumption and physical activity. These variables were: 1) the time a student has known about their relatives T2D diagnosis and 2) severity of their relatives T2D. We found that the longer students knew about their family members T2D, the higher the students T2D knowledge. To the best of our knowledge no study has reported an investigation into the amount of time a person has known about their relatives' T2D diagnosis and how this affects their knowledge of the disease or preventive efforts towards the disease. From our novel results, we also found that knowledge about T2D related protective behaviors are significantly dependent on how long a person has known about their family history of T2D.

Knowledge in general is considered as a relatively malleable individual characteristic (Matzler, Renzl, Mooradian, von Krogh, & Mueller, 2011). Our findings provide support for T2D knowledge as a significant part of understanding various determinants of behavior. Also, for those with a family history of T2D, the time they have known about their positive family history status is also an important part of any investigation in the area. For example, we cannot equally asses a person who knew about their relatives T2D ten years ago versus someone who found out one week ago. This is

because as time goes on, a person is more likely to interact with their relative about the disease and be more exposed in general to the disease (Claassen et al., 2010).

Our results also show that perceived severity for T2D increased if a student had a relative with severe T2D. To the best of our knowledge, no study has measured the relationship between relatives' T2D actual severity (limb amputation, blindness, and heart disease, frequent emergency room visits because of T2D and kidney disease) and perceived T2D severity. We hypothesized that if college students had relatives with severe T2D, their perceived T2D severity will be significantly increased. This is because if an individual has a relative living with T2D who has no complications and manages their T2D well, they are most likely to feel like T2D is not serious and thus would have considerably reduced perceptions of T2D severity. On the other hand, an individual who has been to the emergency room severally with a relative or has a blind or limb-less relative due to T2D is more likely to perceive T2D as a very severe disease. Our results confirmed this hypothesis for F&V consumption with statistical significance ($p<.05$) and a relatively strong beta ($\beta=.33$), and for physical activity with statistical significance ($p<.05$) and a relatively strong beta ($\beta=.34$).

Conclusions and Limitations

The results of this study suggest that tailored lifestyle interventions based on T2D family history status that assess health beliefs/perceptions and emphasize approaches for preventing T2D may be an effective strategy for reducing the burden of T2D. Therefore, interventions and programs targeted at reducing the T2D epidemic through promoting F&V consumption and physical activity may be tailored to individuals based on T2D family history status as these two groups are influenced to T2D related health protective behaviors via different ways. Further, individuals with a T2D family history are at higher risk of developing T2D and can benefit from adopting healthier lifestyles that could potentially reduce their own T2D risk. Altogether, the findings from this study point to the need for innovative methods for T2D prevention education.

Health educators, according to the National Human Genome Research Institute (NHGRI), are experts who publicize genomic information, while concurrently raising awareness of emergent technologies in genomics and educating the population about appropriate healthy behaviors (National Human Genome Research Institute, 2013). In addition, health educators and health care professionals in general are tasked by the Centers for Disease Control (CDC) to assess needs and promote genomics education for communities and also incorporate genomics into planning health interventions and programs (Centers, for Disease Control and Prevention, 2001). Thus, when health educators and other health professionals plan T2D prevention programs, family history status should be a represented component of the intervention procedures. It is vital that health educators assess whether people understand familial risk for T2D and plan accordingly (Claassen et al., 2010; Chen & Goodson 2007b; Chen et al, 2008, Chen &

Goodson 2008). Tailored lifestyle interventions for this group that assess their health beliefs and emphasize approaches for preventing T2D may be an effective strategy for reducing the burden of T2D (Heideman et al., 201, Chen & Goodson 2007a).

Some limitations of this study are as follows: 1) the study was cross-sectional; therefore, we are restricted to associations; 2) the data for this study were acquired through self-report and may have resulted in bias; 3) some cases of T2D are not yet diagnosed (Control, Prevention, Control, & Prevention, 2011) and thus can lead to misclassification of T2D risk; and 4) the study population consisted of college students, meaning the results cannot be generalized to the entire U.S. population. However, the purpose of this study was not necessarily to be able to generalize the results because we were only interested in the college population.

CHAPTER V

CONCLUSIONS

The central purpose of this study was to provide insight into the impact of T2D family history/factors on T2D related preventive behaviors such as physical activity and fruits and vegetable consumption. In order to achieve this purpose, three independent articles were written: (1) a documentation of what the extant literature says on the impact of T2D family history status on T2D-related preventive behaviors and the methodological quality of the papers (Chapter II), (2) a report on quantitative findings on the differences in T2D knowledge (behavioral and genetic) among college students with and without a family history of T2D, and an assessment of the impact of demographic characteristics (age, biological sex, BMI, race and marital status) (chapter III), (3) a report on quantitative findings on the relative impact of behavioral intention, attitude, perceptions (risk and severity), family history and demographic factors (age, biological sex, BMI, race and marital status) on T2D related-preventive behaviors among college students. (Chapter IV).

The major findings from the systematic literature review (Chapter II) were notable. First, majority of the reviewed studies provide supportive evidence for the association between a positive T2D family history status and engagement in various protective behaviors such as healthy diets, physical activity and routine screening. However we found that there was no unified answer to whether having a family member with T2D affects an individual's PA and nutrition behaviors, the literature was consistent in finding a positive relationship between T2D family history and screening. Further findings from this study showed that RCT's aimed at relatives of those with T2D are an

underutilized and this could potentially be an effective strategy to reach a defined group of people at risk. Also, we found that the conceptualization and operationalization of family history status as a construct varied among studies which could possible impact the results. Finally, we found that none of the studies reviewed focused primarily on adolescents or young adults.

The literature has shown repeatedly that lifestyle behaviors developed at a young age set the stage for behaviors to persist into adulthood and subsequently become more difficult to change as an adult (Mikkilä et al., 2004) .Thus, providing a strong rationale as to why the second and third manuscripts focused on college students. The main finding from manuscript 2 (Chapter III) were that: 1) there was lower T2D genetic knowledge than there was for T2D behavior-related knowledge, 2) Whites had much higher T2D knowledge than minority populations, 3)older age and higher BMI were significantly related to increased T2D knowledge, 4) students with a family history of T2D generally knew more about causes of T2D than those without a family history and lastly female students were more likely to have a family member diagnosed with T2D. The results for this study point to some implications for practice and research. More studies need to investigate why minorities have such low knowledge of T2D compared to Whites even though they are more exposed to the disease, via diagnosed family members. Practitioners can also try to target young minorities who also have a family history of T2D for education interventions as they are at higher risk than Whites. Although T2D knowledge may not directly lead to any preventive behaviors, knowledge is still an essential part of the process.

To gauge the influence of behavioral intention, attitude, perceptions (risk and severity), family history and demographic factors (age, biological sex, BMI, race and marital status) on T2D related-preventive behaviors among college students, we proposed utilizing a combined model derived from the Theory of Planned Behavior and the Health Belief Model (Rimer & Glanz, 2005). The study was able to examine the network of interaction between variables and examine their influence on T2D related preventive behaviors via structural equation modelling techniques. Each scale used in the analyses demonstrated good internal consistency.

Relationships within the conceptual model showed that direct predictors of F&V consumption for college students with and without a family history of T2D were age, being white, T2D risk perception and behavioral intention. Relationships within the conceptual model showed that there were no direct predictors of physical activity for college students irrespective of their T2D family history status even after modification indices were applied. An interesting finding was that intention did not predict physical activity but predicted F&V consumption. This result was not surprising because it is possible to have intentions to exercise and never do. However because F&V consumption does not take an individual out of their comfort zone such as exercise, intentions to consume F&V may more easily predict F&V consumption behavior.

Health educators' work in healthcare, community, university, and many other settings, thus, they can utilize findings of this theoretically driven study in their respective work place for the health promotion and prevention of T2D. Also, findings from this dissertation may also be suitable for curriculum development regarding T2D in

health education settings within colleges. Finally, increased knowledge about T2D family history may contribute to primary T2D prevention.

Despite the many contributions this dissertation makes, it is limited by the lack of generalizability to other populations, cross-sectional design which precludes causation, and self-report which may contain bias. Nevertheless, we believe the studies represent an important stride in understanding the impact T2D family history/factors has on T2D related prevention behaviors to help prevent or delay the occurrence of T2D among youth in the US.

Further research could explore the effectiveness of differentiation of health education messages based on family history information (high vs. low vs. no familial risk) and to identify parts of an intervention that are most effective in achieving sustainable lifestyle changes. Also, in order to develop more effective personalized health education messages that fit within people's mental model of T2D risk, it is important to investigate individuals pre-existing illness representations. For instance, how beliefs about Type 2 Diabetes family history and its causation are interrelated with beliefs about the effectiveness of engaging in protective behaviors (Exercise and healthy diet).

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APPENDIX A

SURVEY INSTRUMENT

Q1 what is your biological sex?

- ❍ Male
- ❍ Female

Q2 what is your age?

Q3 what is your race? Tick all that apply.

- ❑ Hispanic
- ❑ Black/African American
- ❑ White
- ❑ Asian
- ❑ Pacific Islander/Native American
- ❑ Other
- ❑ Prefer not to answer

Q4 what is your marital status?

- ❍ Single
- ❍ Married
- ❍ Divorced
- ❍ Separated

Q5 What is your class level?

- ❍ Freshman
- ❍ Sophomore
- ❍ Junior
- ❍ Senior

Q6 What is your height? (Inches)

Q7 What is your weight? (Pounds)

Q8 What school do you attend?

- ❍ Texas A&M University
- ❍ University of the Incarnate Word
- ❍ Prairie View A&M University
- ❍ Blinn College

Q9 About how many cups of vegetables (including 100% pure vegetable juice) do you eat or drink each day? (1 cup of vegetables could be equal to: 3 broccoli spears, 1 cup cooked leafy greens, 2 cups lettuce or raw greens, 12 baby carrots, 1 medium potato, 1 large sweet potato,1 large ear of corn, 1 large raw tomato, 2 large celery sticks, 1 cup of cooked beans, etc)

- ❍ Never
- ❍ 1/2 cup or less
- ❍ 1/2 cup to 1 cup
- ❍ 1 to 2 cups
- ❍ 2 to 3 cups
- ❍ 3 to 4 cups
- ❍ 4 or more cups

Q10 About how many cups of fruit (including 100% pure fruit juice) do you eat or drink each day? (1 cup of fruit could be equal to: 1 small apple, 1 large banana, 1 large orange, 8 large strawberries, 1 medium pear, 2 large plums, 32 seedless grapes, 1 cup (8 oz.) fruit juice, ½ cup dried fruit, 1 inch-thick wedge of watermelon)

- ❍ None
- ❍ 1/2 cup or less
- ❍ 1/2 cup to 1 cup
- ❍ 1 to 2 cups
- ❍ 2 to 3 cups
- ❍ 3 to 4 cups
- ❍ 4 or more cups

Q11 In the past 7 days, how many times did you eat at a fast food restaurant e.g. McDonald's, Burger King, Dairy Queen, Wendy's etc.?

- ❍ 0 days
- ❍ 1 day
- ❍ 2 days
- ❍ 3 days
- ❍ 4 days
- ❍ 5 days
- ❍ 6 days
- ❍ 7 days

Q12 When available, how often do you use posted/provided calorie information in deciding what to order/buy?

- ❍ Never
- ❍ Rarely
- ❍ Sometimes
- ❍ Most of the Time
- ❍ Always

Q13 How often do you eat sweets such as cookies, candy bars, or ice cream in place of dinner?

- ❍ Never
- ❍ Rarely
- ❍ Sometimes
- ❍ Most of the Time
- ❍ Always

Q14 Not counting any diet soda or diet pop, about how often do you drink regular soda or pop in a typical week?

- ❍ 7 days a week
- ❍ 6 days a week
- ❍ 5 days a week
- ❍ 4 days a week
- ❍ 3 days a week
- ❍ 2 days a week
- ❍ 1 day a week
- ❍ I don't drink any regular soda or pop

Q15 In answering the following questions: Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal; &

Moderate physical activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

Q16 During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

- ❍ 0 days
- ❍ 1 day
- ❍ 2 days
- ❍ 3 days
- ❍ 4 days
- ❍ 5 days
- ❍ 6 days
- ❍ 7 days

Q17 How much time in total did you usually spend on one of those days doing vigorous physical activities?

_____ Hours
_____ Minutes

Q18 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.

- ❍ 0 days
- ❍ 1 day
- ❍ 2 days
- ❍ 3 days
- ❍ 4 days
- ❍ 5 days
- ❍ 6 days
- ❍ 7 days

Q19 How much time in total did you usually spend on one of those days doing moderate physical activities?

_____ Hours
_____ Minutes

Q20 During the last 7 days, on how many days did you walk? This includes walking at work and at home, walking to travel from place to place, and any other walking that you did solely for recreation, sport, exercise or leisure.

- ❍ 0 days
- ❍ 1 day
- ❍ 2 days
- ❍ 3 days
- ❍ 4 days
- ❍ 5 days
- ❍ 6 days
- ❍ 7 days

Q21 How much time in total did you usually spend walking on one of those days?

_____ Hours
_____ Minutes

Q22 This question is about the time you spent sitting on weekdays while at work, at home, while doing course work and during leisure time. This includes time spent sitting at a desk, visiting friends, reading, traveling on a bus or sitting or lying down to watch television.

Q23 During the last 7 days, how much time in total did you usually spend sitting on a week day?

_____ Hours
_____ Minutes

Q25 Are you adopted?

- ❍ Yes
- ❍ No

Q24 The following question asks about your family history of Type 2 Diabetes

Q26 Do any of the following members in your family have Type 2 Diabetes?

	Yes	No	I don't Know	Not Applicable because I do not have
Mother	❍	❍	❍	❍
Father	❍	❍	❍	❍
Brother or Sister	❍	❍	❍	❍
Any Grandparents on Mothers Side	❍	❍	❍	❍
Any Grandparents on Fathers Side	❍	❍	❍	❍
Aunts or Uncles on Mothers side	❍	❍	❍	❍
Aunts or Uncles on Fathers side	❍	❍	❍	❍
Any Cousins on Mothers side	❍	❍	❍	❍
Any Cousins on Fathers side	❍	❍	❍	❍

Answer If Do any of the following members in your family have Type 2 Diabetes? - Yes Is Selected

Q27 Regarding the family member or members you previously selected please indicate the amount of time (in years) you have known about the diagnosis of Type 2 Diabetes.

_____ Mother
_____ Father
_____ Brother or Sister
_____ Any Grandparents on Mothers Side
_____ Any Grandparents on Fathers Side
_____ Aunts or Uncles on Mothers side
_____ Aunts or Uncles on Fathers side
_____ Any Cousins on Mothers side
_____ Any Cousins on Fathers side

Answer If Do any of the following members in your family have Type 2 Diabetes? - Yes Is Selected

Q28 The following question is about the severity of your family member or members Type 2 Diabetes

Answer If Do any of the following members in your family have Type 2 Diabetes? - Yes Is Selected

Q29 Please select if your family member or members with Type 2 Diabetes has experienced or is experiencing any of the following:

	Yes	No	I don't know
Kidney Disease	❍	❍	❍
Heart Disease	❍	❍	❍
Blindness	❍	❍	❍
Coma	❍	❍	❍
Limb Amputation	❍	❍	❍
Emergency Room Visit because of Type 2 Diabetes	❍	❍	❍

Q30 Rate your current knowledge about Type 2 Diabetes on a scale of 0 to100 where 0 means knowing nothing and 100 means knowing everything you could possibly know.

_____

Q31 This time, using that same scale, estimate how much knowledge you think you NEED on Type 2 Diabetes

_____

Q32 Does weight loss decrease a person's chance of developing Type 2 Diabetes?

❍ Definitely does not decrease
❍ Probably does not decrease
❍ Probably decreases
❍ Definitely decreases
❍ I don't know

Q33 Does a healthy diet decrease a person's chance of developing Type 2 Diabetes?

- ❍ Definitely does not decrease
- ❍ Probably does not decrease
- ❍ Probably decreases
- ❍ Definitely decreases
- ❍ I don't know

Q34 Does regular exercises decrease a person’s chance of developing Type 2 Diabetes?

- ❍ Definitely does not decrease
- ❍ Probably does not decrease
- ❍ Probably decreases
- ❍ Definitely decreases
- ❍ I don't know

Q35 Does clinical screening for Type 2 Diabetes decrease a persons chance of developing Type 2 Diabetes?

- ❍ Definitely does not decrease
- ❍ Probably does not decrease
- ❍ Probably decreases
- ❍ Definitely decreases
- ❍ I don't know

Q36 Does a persons genes increase the chance of developing Type 2 Diabetes?

- ❍ Definitely does not increase
- ❍ Probably does not increase
- ❍ Probably increases
- ❍ Definitely increases
- ❍ I don't know

Q37 How likely are you to develop Type 2 Diabetes because someone in your family has it?

- ❍ Very Unlikely
- ❍ Unlikely
- ❍ Somewhat Unlikely
- ❍ Somewhat Likely
- ❍ Likely
- ❍ Very Likely

Q38 Indicate the extent to which you believe that a given cause could be a cause of Type 2 Diabetes (1 = definitely not; 5 = definitely yes)

_____ Heredity
_____ Aging
_____ Lifestyle (smoking, alcohol use, lack of physical activity and nutrition habits)
_____ Stress or worry
_____ Country of origin

Q39 The following questions are on your alcohol consumption:

Q40 How often do you have a drink containing alcohol?

- ❍ Never
- ❍ Monthly or less
- ❍ 2-4 times a Month
- ❍ 2-3 Times a week
- ❍ 4 or more times a week

Q41 How many standard drinks containing alcohol do you have on a typical day?

- ❍ 0
- ❍ 1 or 2
- ❍ 3 or 4
- ❍ 5 or 6
- ❍ 7 to 9
- ❍ 10 or more

Q42 How often do you have six or more alcoholic drinks on one occasion?

- ❍ Never
- ❍ Less than monthly
- ❍ Monthly
- ❍ Weekly
- ❍ Daily or almost daily

Q43 Has any friend advised you about exercising regularly?

- ❍ Yes
- ❍ No

Q44 Has any family member advised you about exercising regularly?

- ❍ Yes
- ❍ No

Q45 Has a Doctor, Nurse or other health care professional advised you about exercising regularly?

- ❍ Yes
- ❍ No

Q46 What do you think your chance is of developing Type 2 Diabetes in your lifetime? Please choose a number between 0 (no chance of Type 2 Diabetes) and 100 (definitely will get Type 2 Diabetes).

_____

Q47 What is the chance of you getting Type 2 Diabetes compared with an average man/woman your age?

- ❍ Much Lower
- ❍ Slightly Lower
- ❍ About the Same
- ❍ Higher
- ❍ Much Higher

Q48 How likely do you think it is that you will develop Type 2 Diabetes during the next 5 years? Please choose a number between 0 (no chance of Type 2 Diabetes) and 100 (definitely will get Type 2 Diabetes).

_____

Q49 I believe that Type 2 Diabetes is severe.

- ❍ Strongly Disagree
- ❍ Disagree
- ❍ Agree
- ❍ Strongly Agree

Q50 I believe that Type 2 Diabetes is serious.

- ❍ Strongly Disagree
- ❍ Disagree
- ❍ Agree
- ❍ Strongly Agree

Q51 I believe that Type 2 Diabetes is significant.

- ❍ Strongly Disagree
- ❍ Disagree
- ❍ Agree
- ❍ Strongly Agree

Q52 Indicate the level to which you feel that regular exercise is: (0 being the lowest; 100 being the highest)

_____ Bad----------Good
_____ Unhealthy-----Healthy
_____ Unpleasant-Pleasant
_____ Not useful---Useful
_____ Not beneficial--------Beneficial
_____ Unwise----------Wise

Q53 Indicate the level to which you feel that eating healthy foods regularly is: (0 being the lowest; 100 being the highest)

_____ Bad----------Good
_____ Unhealthy-----Healthy
_____ Unpleasant-Pleasant
_____ Not useful---Useful
_____ Not-beneficial-----Beneficial
_____ Unwise----------Wise

Q54 Indicate the level to which you feel Binge drinking (consume five or more standard alcoholic drinks for males, or four or more standard alcoholic drinks for females, in about 2 hours) is: (0 being the lowest; 100 being the highest)

_____ Bad----------Good
_____ Unhealthy-----Healthy
_____ Unpleasant-Pleasant
_____ Not useful---Useful
_____ Not-beneficial----Beneficial
_____ Unwise--------Wise

Q55 In the next three months, I intend to:

_____ Eat healthy foods
_____ Exercise more
_____ Binge Drink (consume five or more standard alcoholic drinks for males, or four or more standard alcoholic drinks for females, in about 2 hours)

Q57 Thank you for filling out the survey! :) Click the next button if you want to be entered for a drawing of $40 Walmart gift card!

APPENDIX B

Table B-1. Matrix of the 11 studies reviewed and their characteristics

Authors	Purpose of Study	Study Design	Instrument	How FH was Operationalized and Conceptualized	Sample characteristics	Theory reported	Data Analysis	T2D related risk behavior measured	Outcome results	Data source	Baseline year	Effect size & Confidence Interval &RR
aptiste-Roberts K, Gary TL, Beckles GL, et al.	"Analyze if individuals with a FH of T2D would be more aware of risk factors and more likely to engage in healthy behaviors than would individual without T2D FH"	Cross-sectional study	Questionnaire	First degree relatives only	African Americans, 18 +, n=1122, both male and female	Health Belief Model	Descriptive, Multivariate	Diet/Physical Activity/Screening	"Those with a family history of T2D knew more about T2D risk factors, eat more servings of F&V and be screened for T2D".	Project DIRECT (T2D Interventions Reaching and Educating Communities Together)	N/A	"For those with FH+: Greater awareness of risk factors: (CI=1.10-1.29) (RR=1.20), More likely to consume 5 or more F&V per day (CI=1.02-1.66) (R=1.31), More screening for T2D (CI=1.12-1.29) (RR=1.20)"

Table B-1. Matrix of the 11 studies reviewed and their characteristics continued

Chang M, Valdez R, Liu T, Yang Q, et al.	"Test the association of FH of T2D with the adoption of T2D risk–reducing behaviors and whether this association is strengthened by physician advice".	Cross-sectional study	Questionnaire	First degree relatives only	8,598 adults (aged ≥20 years), non-Hispanic white, non-Hispanic black, Mexican American, other, both male and female	Not reported	Descriptive, Multiple logistic regression	controlling or losing weight, increasing physical activity, and reducing the amount of dietary fat or calories	"In univariate analysis, adults with a family history of T2D were more likely to perform these risk-reducing behaviors compared with adults without a family history. Physician advice was strongly associated with each of the behavioral changes ($P < 0.01$), and this did not differ by family history of T2D".	2005–2008 National Health and Nutrition Examination Survey (NHANES)	N/A	"Compared with FHx− adults, FHx+ adults were more likely ($P < 0.01$) to have controlled or lost weight, increased exercise, or changed their diet regardless of physician advice (53.2 vs. 46.5%, 48.5 vs. 44.4%, and 51.9 vs. 44.5%, respectively)".

Table B-1. Matrix of the 11 studies reviewed and their characteristics continued

Forsyth LH, Goetsch VL.	"To assess if individuals with a family history of T2D are aware of their risk and if they are engaging in preventive behaviors".	Cross-sectional study	Questionnaire	Have a biological Parent with T2D only	30 adults with FH+ compared with 30 adults FH-.	Not reported	Descriptive, ANOVA	Diet/Physical Activity/Weight Control/Physician Screening	"The FH+ group had higher Health Protective Behaviors $t(58) = 2.91, p<0.002$ than those without FH+. FH+ group did not differ significantly from control group but reported more weight control behaviors than the control group"	N/A Primary data	N/A	Study used only ANOVA group comparisons

Table B-1. Matrix of the 11 studies reviewed and their characteristics continued

Hariri S, Yoon PW, Qureshi N, et al.	"To evaluate self-reported FH+ of T2D. Specific aims were 3. 1) To assess family history as of T2D as an independent risk factor for T2D; 2)Possible modification of the associations between familial risk and T2D by other risk factors; 3) relationship between FH+ and perceived risk of disease and the presence of	Cross-sectional study	"Questionnaire**(High risk**=two first degree relatives, one first and two second degree relatives or three second degree relatives; **Moderate risk**=one first and one second degree relative, one first degree relative, mother and father, two second degree relatives; **Average risk**=one second degree relative"	First and second degree relatives	Ages 18 and older, n=4345, 82.1% were >35 years, females=56.7%, males=43.3% white=69.8%, AA=12.2, Hispanic=11.6	Not reported	Descriptive, Multivariate	Screening, collected family history information, talked about T2D with family, Exercise, general lifestyle changes	"compared to those at average risk, people with high or moderate risk were more likely to make lifestyle changes to prevent T2D (OR: 2.2, 95% C.I: 1.8,2.7; OR: 4.5 95% CI 3.6,5.6"	Health Styles 2004	N/A	"compared to those at average risk, people with high or moderate risk were more likely to make lifestyle changes to prevent T2D (OR: 2.2, 95% C.I: 1.8,2.7; OR: 4.5 95% CI 3.6,5.6"

	risk reducing behaviors”											

Table B-1. Matrix of the 11 studies reviewed and their characteristics continued

Omolafe A, Mouttapa M, McMahan S, et al.	"this study examined whether the Health Belief Model constructs of perceived susceptibility, perceived severity, and knowledge about T2D, as well as level of physical activity differed in African Americans with a positive family history of T2D (including parents, siblings, grandparents, aunts, uncles,	Cross-sectional study	Questionnaire	First and second degree relatives	"African Americans, 18 +, both male and female, Participants were 43.6% male (n = 58) and 56.4% female (n= 75). Mean age was 35.9 years (SD = 12.9)".	Health Belief Model	"Pearson's chi-square test, Kruskal-Wallis test, multiple linear regression and multiple logistic regression".	Physical Activity	"The results indicated that those with a positive family history engaged in more physical activity (M = 3021.8 MET-minutes/wk, SD = 1623.0) relative to those with a negative family history (M = 1562.0 MET-minutes/wk,"	N/A Primary data	N/A	N/A

	and cousins) compared to African Americans without a family history”.											

Table B-1. Matrix of the 11 studies reviewed and their characteristics continued

Pijl M, Timmermans DR, Claassen L, et al.	To assess the potential effectiveness of communicating familial risk of T2D on illness perceptions and self-reported behavioral outcomes.	randomized control	Questionnaire	one or more first-degree relatives	"Mean age at baseline was 67.1 5.3 years; 43% were men; 5% completed higher vocational training or university; mean SD BMI was 28.3 4.3 kg/m2; and 52"	Not explicitly reported but used constructs from Theory of Planned Behavior	Descriptive, ANCOVA	Diet/Physical Activity/Test for T2D	"Compared with individuals receiving general risk information, those receiving familial risk information reported having eaten more healthily (P <0.01) after 3 months. Being more physically active also showed a marginal significant difference (P = 0.08)".	http://care.T2Djournals.org/content/25/10/1784.long	2007	N/A because ANCOVA was used

Table B-1. Matrix of the 11 studies reviewed and their characteristics continued

Qureshi N, Kai J.	This survey analysis determined whether patients who were informed by their doctors of familial DM risk acknowledged that risk and took steps to reduce it.	Cross-sectional study	Questionnaire	First and second degree relatives	N=3,323, gender, income, educational status, and self-reported racial group	Not reported	Multivariate logistic regression	screening, diet and exercise	"Forty-one percent (n = 616) of the question responders that had DM family histories were informed by their doctors of their familial risk; the chance of being informed increased with the number of relatives that had the disease. Members of the informed group were more likely than those in the non-informed group to report lifestyle changes to prevent DM (odds ratio [OR] 4.3, 95% confidence interval [CI] 3.5–5.2) and being tested for DM (OR 2.9, 95% CI 2.4–3.6), although no significant improvement occurred in their U.S.-recommended exercise activity (OR 0.9, 95% CI 0.7–1.1)".	HealthStyles 2004	N/A	"Members of the informed group were more likely than those in the non-informed group to report lifestyle changes to prevent DM (odds ratio [OR] 4.3, 95% confidence interval [CI] 3.5–5.2) and being tested for DM (OR 2.9, 95% CI 2.4–3.6), although no significant improvement occurred in their U.S.-recommended exercise activity (OR 0.9, 95% CI 0.7–1.1)".

Table B-1. Matrix of the 11 studies reviewed and their characteristics continued

Slattery ML, Murtaugh MA, Lanier AP, et al.	"We evaluated the association between having a positive family history and health behaviors to determine if those reporting a family history were more likely to report lifestyles that put them at risk of developing these health conditions".	Cross-sectional study	Questionnaire	First-degree relatives only	Male and female, 18 and older, n=10,374	Not reported	T-test and chi-squared statistics.	Physical activity, Diet, screening	Participants with a family history of T2D reported less vigorous physical activity than their counterparts without a FH of T2D.	Alaska and Navajo sites of the Education and Research Towards Health Study	N/A	N/A

Table B-1. Matrix of the 11 studies reviewed and their characteristics continued

Wijdenes M, Henneman L, Qureshi N, et al.	"Determine the effect of tailored web-based diabetic familial risk information on risk-reducing behavior and perceptions of individuals"	RCT	Questionnaire	People with one (or more) first-degree relative with T2D	n=1,120, males and females, 18 and older, Control group with FH:n=286 and intervention n=288; Dutch	Not reported	Descriptive, Multivariate, Logistic regression, Chi-square	Physical Activity, saturated fat intake, attitudes towards testing for T2D	"Familial risk communication had no effect on saturated fat intake, PA level, or attitudes towards testing for T2D. Education level was an effect modifier for the effect on saturated fat intake, therefore sub-group analysis were performed. A decrease in self-reported saturated fat intake for low-educated individuals in the intervention group when compared to the control group was found".	The Preventing T2D Controlled Trial (PreDiCT) was registered at the Dutch Trial Register (NTR1938)	2013	Saturated fat intake a: CI=-0.29(-0.85 to 0.27) PA intensity CI=0.03 (-0.08 to 0.13), PA frequency CI=0.02 (-0.15 to 0.54). T2D testing attitudes CI = -0.07(-0.23 to 0.09)

Table B-1. Matrix of the 11 studies reviewed and their characteristics continued

Zlot AI, Bland MP, Silvey K, Epstein B, Mielke B, Leman RF	"Evaluate, among people with T2D, associations between family history of T2D and 1) patients' reports of health care provider practices, 2) patients' perceived risk of developing T2D, and 3) patients' behaviors associated with an increased risk of developing T2D".	Cross-sectional study	Questionnaire	"1) average: no first-degree relatives with T2D or adopted with unknown family history status of blood relatives; 2) moderate: 1 first-degree relative with T2D; and 3) strong: at least 2 first-degree relatives with T2D"	n=6,039, male and females without T2D.	Transtheoretical Model of behavior change	Pearson $\chi 2$ tests and Logistic regression	Physical activity, Diet, screening	"Compared with respondents at average risk, respondents with a strong FH were more likely to report making changes in diet and exercise. Compared with respondents without a FH of T2D, respondents with a strong or moderate FH of T2D were more likely to report making lifestyle changes in their diet or physical activity and more likely to report they were trying to lose weight".	2005 Oregon Behavioral Risk Factor Surveillance System	N/A	(OR, 1.7; 95% CI, 1.4-2.1). Compared with respondents without a family history of T2D,

Table B-1. Matrix of the 11 studies reviewed and their characteristics continued

Zlot AI, Cox SL, Silvey K, Leman R	"Examine the association of family history of T2D, cardiovascular disease, colorectal cancer, breast cancer and 1) patient reported clinical recommendations, 2) adoption of preventive, screening behaviors, 3)chronic disease risk factors"	Cross-sectional study	Questionnaire	at least 1 first-degree relative (parent, sibling or child) with T2D	n=6,039, male and females without T2D.	Not Reported	pearson $\chi 2$ tests and logistic regression	Physical activity, Diet, screening	"People with a positive family history were more likely to report making lifestyle changes to decrease their risk of disease than those with a negative family history. For T2D Odds ratio= 2.0, CI=1.4-2.0"	2006, 2007 , 2008 AND 2009 Oregon Behavioral Risk Factor survellience system	N/A	For T2D Odds ratio= 2.0, CI=1.4-2.0