Relationship Between College Students’ Knowledge of the Risk Factors for Type 2 Diabetes and Health Behaviors

Elizabeth Keida
St. John Fisher College, ekeida@sjfc.edu

Follow this and additional works at: https://fisherpub.sjfc.edu/education_etd

Part of the Education Commons

How has open access to Fisher Digital Publications benefited you?

Recommended Citation
Keida, Elizabeth, "Relationship Between College Students’ Knowledge of the Risk Factors for Type 2 Diabetes and Health Behaviors" (2016). Education Doctoral. Paper 278.

Please note that the Recommended Citation provides general citation information and may not be appropriate for your discipline. To receive help in creating a citation based on your discipline, please visit http://libguides.sjfc.edu/citations.

This document is posted at https://fisherpub.sjfc.edu/education_etd/278 and is brought to you for free and open access by Fisher Digital Publications at St. John Fisher College. For more information, please contact fisherpub@sjfc.edu.
Relationship Between College Students’ Knowledge of the Risk Factors for Type 2 Diabetes and Health Behaviors

Abstract
Type 2 diabetes (T2D) is one of the leading causes of death worldwide and its prevalence is growing across the United States in all populations. The purpose of this study was to investigate the impact knowledge regarding T2D has on health behaviors, specifically, behaviors related to physical activity and sugar and fat consumption. A questionnaire was distributed through email to 500 undergraduate students at one specific campus of the State University of New York college system. Fifty-one of these subjects met the eligibility criteria and were used as part of this study. The questionnaire instrument consisted of four self-report areas: (a) demographics, (b) current knowledge of T2D risk factors, (c) physical activity behavior, and (d) dietary behavior. The researcher found the average T2D knowledge score was 33.7, physical activity score was 3.5 sessions per week, sugar consumption frequency score was 25.2, fat consumption 3.6, and junk food consumption was 28.8. The researcher failed to support the hypotheses that knowledge was significantly correlated with health behaviors. However, the effect size for each of these relationships was small to medium, indicating that with a larger sample we would expect to see a significant correlation. Overall, the researcher concluded that the college student population is overweight and most students do not practice positive health behaviors to prevent chronic disease, such as T2D. It is recommended that colleges and universities consider promoting healthier lifestyles for their students by offering more opportunities for physical activity, good nutrition, and health education/support groups.

Document Type
Dissertation

Degree Name
Doctor of Education (EdD)

Department
Executive Leadership

First Supervisor
C. Michael Robinson

Subject Categories
Education

This dissertation is available at Fisher Digital Publications: https://fisherpub.sjfc.edu/education_etd/278
Relationship Between College Students’ Knowledge of the Risk Factors for Type 2 Diabetes and Health Behaviors

By

Elizabeth Keida

Submitted in partial fulfillment of the requirements for the degree Ed.D. in Executive Leadership

Supervised by
C. Michael Robinson, Ed. D.

Committee Member
Jodi Dowthwaite, Ph. D.

Ralph C. Wilson, Jr. School of Education
St. John Fisher College

August 2016
Biographical Sketch

Elizabeth Keida is currently a Visiting Assistant Professor at the State University of New York (SUNY) at Oswego in the Health Promotion and Wellness Department. Mrs. Keida attended Le Moyne College from 2004 to 2007 and graduated with a Bachelor of Science in Biology in 2007. She later attended Syracuse University from 2008 to 2012 and graduated with a Master’s of Science in Secondary (7-12) Science Education: Biology in 2009 and Master’s of Science in Exercise Physiology in 2012. Mrs. Keida came to St. John Fisher College in the summer of 2014 and began her doctoral studies in the Ed.D. Program in Executive Leadership. She pursued her research in investigating the relationship between college students’ knowledge of the risk factors for Type 2 Diabetes and health behaviors under the direction of Dr. C. Michael Robinson and Dr. Jodi Dowthwaite and received the Ed.D. in 2016.
Abstract

Type 2 diabetes (T2D) is one of the leading causes of death worldwide and its prevalence is growing across the United States in all populations. The purpose of this study was to investigate the impact knowledge regarding T2D has on health behaviors, specifically, behaviors related to physical activity and sugar and fat consumption.

A questionnaire was distributed through email to 500 undergraduate students at one specific campus of the State University of New York college system. Fifty-one of these subjects met the eligibility criteria and were used as part of this study. The questionnaire instrument consisted of four self-report areas: (a) demographics, (b) current knowledge of T2D risk factors, (c) physical activity behavior, and (d) dietary behavior.

The researcher found the average T2D knowledge score was 33.7, physical activity score was 3.5 sessions per week, sugar consumption frequency score was 25.2, fat consumption 3.6, and junk food consumption was 28.8. The researcher failed to support the hypotheses that knowledge was significantly correlated with health behaviors. However, the effect size for each of these relationships was small to medium, indicating that with a larger sample we would expect to see a significant correlation.

Overall, the researcher concluded that the college student population is overweight and most students do not practice positive health behaviors to prevent chronic disease, such as T2D. It is recommended that colleges and universities consider promoting healthier lifestyles for their students by offering more opportunities for physical activity, good nutrition, and health education/support groups.
# Table of Contents

Biographical Sketch ........................................................................................................... iii  
Abstract .............................................................................................................................. iv  
Table of Contents ................................................................................................................ v  
List of Tables ................................................................................................................... viii  
List of Figures .................................................................................................................... ix  
Chapter 1: Introduction ....................................................................................................... 1  
  Problem Statement .......................................................................................................... 2  
  Theoretical Rationale ...................................................................................................... 6  
  Statement of Purpose ..................................................................................................... 11  
  Hypotheses and Research Questions ............................................................................ 11  
  Significance of the Study .............................................................................................. 13  
  Definition of Terms....................................................................................................... 15  
  Chapter Summary ......................................................................................................... 18  
Chapter 2: Review of the Literature .................................................................................. 19  
  Introduction and Purpose .............................................................................................. 19  
  Diabetes ......................................................................................................................... 19  
  Theory: Health Belief Model ........................................................................................ 29  
  Knowledge and the Health Belief Model ...................................................................... 49  
  Demographics: Health Behaviors ............................................................................... 107  
  Sociopsychologic Aspects of College Students ......................................................... 120
<table>
<thead>
<tr>
<th>Appendix</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendix D</td>
<td>204</td>
</tr>
<tr>
<td>Appendix E</td>
<td>207</td>
</tr>
<tr>
<td>Appendix F</td>
<td>221</td>
</tr>
<tr>
<td>Appendix G</td>
<td>222</td>
</tr>
</tbody>
</table>
# List of Tables

<table>
<thead>
<tr>
<th>Item</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 2.1</td>
<td>Timeline of the Health Belief Model</td>
<td>36</td>
</tr>
<tr>
<td>Table 4.1</td>
<td>Descriptive Statistics</td>
<td>152</td>
</tr>
<tr>
<td>Table 4.2</td>
<td>Spearman’s Rank Correlations for T2D Knowledge</td>
<td>157</td>
</tr>
<tr>
<td>Table 4.3</td>
<td>Spearman’s Rank Correlations for BMI</td>
<td>159</td>
</tr>
</tbody>
</table>
# List of Figures

<table>
<thead>
<tr>
<th>Item</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1.1</td>
<td>Health Belief Model</td>
<td>8</td>
</tr>
</tbody>
</table>
Chapter 1: Introduction

Many risk factors can increase susceptibility to type 2 diabetes (T2D), including obesity, physical inactivity, high blood pressure, abnormal cholesterol, genetics, racial/ethnic background, age, and prior gestational diabetes (NDS, 2014). Some of the risk factors are non-modifiable, such as genetics, racial/ethnic background, and a history of gestational diabetes. The more risks an individual has, the more likely they are to develop T2D. With the practice of good healthy behavior, obesity is one risk factor that can be modifiable. Those who have non-modifiable risk factors of T2D should be aware of the positive health behaviors they can implement to help prevent the onset of T2D (NDS, 2014).

Several studies, including those conducted by the Diabetes Prevention Program Research Group, have demonstrated that T2D is preventable in individuals who are aware of the risk factors associated with the condition (Knowler et al., 2002, 2009; Tuso, 2014). Knowledge may be a critical factor in the prevention of T2D for all populations, including those who do possess non-modifiable risk factors.

College students are the population of interest, because they are at a time in their life where substantial changes are taking place in their personal lives (Conley, Travers, & Bryant, 2013). Students are beginning to make decisions related to personal behaviors without the influence of a caregiver; their decisions can have a significant impact on their future. The dissertation topic is focused on college students’ health behaviors that put them at risk for developing T2D later in life.
Colleges have a social and moral responsibility to provide their students with information regarding positive health behaviors to prevent development of disease and illness later in life (Mead, 1949). The college is responsible for eliminating health disparities among students who are enrolled at the university. It is much more expensive to undergo treatments for T2D than it is to prevent development of T2D through healthy behaviors. Therefore it is imperative that students are equipped with the tools to help them prevent disease and illness. This research could lead to the development and implementation of mandatory health interventions on college campuses for all college students to increase knowledge and improve health behaviors.

**Problem Statement**

Since 2009, the prevalence of chronic disease, especially diabetes, has become more prominent across all ages in the United States population (NDS, 2014). Diabetes is one of the leading causes of death in the US, and it is increasing worldwide (Lefebvre & Pierson, 2004; NDS, 2014). Over 28 million U.S. adults, 20 years and older, have type 1 and type 2 diabetes (T1D/T2D), and by 2050, it is expected that one in three adults will be diagnosed with T2D (Heianza et al., 2011; NDS, 2014).

Diabetes is not only a concern because it can lead to premature death, but it can also cause health complications that can interfere with quality of life (QOL) (Goldney, Fisher, Phillips, & Wilson, 2004; Kiadaliri, Najafi, & Mirmalwek-Sani, 2013). With a diabetes diagnosis, generally one or more co-existing conditions exist such as hypertension, obesity, cardiovascular disease, stroke, kidney disease, blindness, amputations, and depression (Goldney et al., 2004; NDS, 2014). These co-existing conditions are more commonly seen with cases of T2D.
T2D was chosen as the primary focus of this research, because it has become a great public health problem due to its rapid increase in total incidence, prevalence at younger ages, and years spent with condition. From 2010-2012, the number of new diabetes cases was 1,292,000 (23.5% per 1,000) for ages 45 and older (American Diabetes Statistics, 2014). It is common for diabetes to be initially diagnosed in this age population, therefore there is a high prevalence of new cases (NDS, 2014). Additionally, in 2012, there were 4.3 million diabetes cases between the ages of 20 and 44 years of age, including nearly 0.4 million new cases from 2009 to 2012 (NDS, 2014; United States Census Bureau, 2012). Development of T2D at this younger age increases risk of coexisting medical conditions/complications and premature death. This is a very early age for such a large number of young individuals to live with an impaired QOL. This increases lifetime medical costs and the probability of health complications and/or premature death (NDS, 2014).

T2D is also a public health concern due to its occurrence in even younger populations, under age 20 (NDS, 2014). Rather than limiting diagnosis to only adulthood, T2D is becoming prevalent in children and adolescents (Fagot-Campagna, 2000; Fagot-Campagna et al., 1999; NDS, 2014). Of U.S. youths under 20 years of age, in 2001, 0.34 per 1,000 (588 of 1.7 million youth), were diagnosed with T2D, and in 2009, 0.46 per 1,000 (819 of 1.8 million youth), were diagnosed with T2D (Dabelea et al., 2014). Furthermore, trends among youths were not only statistically significant, but statistical significance was also seen across all ethnicities of youth populations in the US ($p<0.001$). Currently, 17% of U.S. children and adolescents aged 2-19 are considered
obese, which puts this population at greater risk of T2D (Ogden, Carroll, Kit, & Flegal, 2014).

There are many risk factors that can increase susceptibility to T2D, including obesity, physical inactivity, high blood pressure, abnormal cholesterol, genetics, racial/ethnic background, age, and prior gestational diabetes (NDS, 2014). The more risk factors that an individual has, the more likely they are to develop T2D. Some of the risk factors are non-modifiable, such as genetics, racial/ethnic background, and a history of gestational diabetes. Those who have inherited risk factors of T2D may not develop T2D, but it is essential for them to be aware of the positive health behaviors they can implement to help prevent the onset of T2D. Obesity, high blood pressure, and high cholesterol are risk factors that may be modifiable with positive health behaviors (NDS, 2014).

Many adolescents have a caregiver who can help to guide their daily life decisions, more specifically behavioral choices. Part of the college experience is freedom to make own decisions. Some of these decisions include those related to health behaviors. If college students adopt, or continue, poor health behaviors, they are more likely to continue them into adulthood. Long-term poor health behaviors can predispose them to T2D, which could result in co-existing conditions and premature death (Doak, 2006).

Several studies, including those conducted by the Diabetes Prevention Program Research Group, have demonstrated that T2D is preventable in individuals who are aware of the risk factors associated with the condition (Knowler et al., 2002, 2009; Tuso, 2014).
Knowledge may be a critical variable in prevention of T2D in all people, including those who do possess a non-modifiable risk factor (Knowler et al., 2002, 2009; Tuso, 2014).

College students experience many challenges in the transition from living in their home community with family and friends, to college where their surroundings are unfamiliar (Conley, Travers, & Bryant, 2013). Personal health decisions related to physical activity, nutrition, and stress may have a significant impact on the adult lives of college students. Poor health and nutritional habits established in young adulthood can increase risks associated with developing a chronic disease, such as T2D, later in life. During this time, when students undergo a considerable lifestyle transition, they may not be aware of the role that risk factors and current behaviors may have on their future health. This lack of knowledge can be a predisposing factor for adverse student behavior (Thomas, 1994). Therefore, it is essential to study the existing knowledge of college students to see if there is a correlation between their health knowledge and health behaviors related to the prevention of T2D.

The health belief model (HBM) is used to predict health behaviors (Rosenstock, 1966). The variables and constructs are value-laden, therefore the likelihood of the behavior to occur increases when the individual believes the behavior will benefit them. One of the variables is knowledge. Knowledge is the basis for the constructs of the HBM. Few studies have examined knowledge as the primary focus when implementing the HBM. Those studies that have focused on knowledge did not sample a college student population (Abbaszadeh, Borhani, & Asadi, 2011; Alidosti et al., 2012; Ghodsbin, Zare, Jahanbin, Ariafar, & Keshavarzi, 2014; Jones, Weaver, Grimley, Appel, & Ard, 2006; Sharifirad, Entezari, Kamran, & Azadbakht, 2009). Furthermore, most
research in the college population focuses on overall health knowledge and its impact on health behaviors (Abood, Black, & Birnbaum, 2004; Franko et al., 2008; Ha & Caine-Bish 2009; Ha, Caine-Bish, Holloman, & Lowry-Gordon, 2009; Ha & Caine-Bish 2011; Hivert, Langlois, Berard, Cuerrier, & Carpentier, 2007; Kolodinsky, Harvey-Berino, Berlin, Johnson, & Reynolds, 2007; Krešić, Jovanović, Žeželj, Cvjanović, & Izević, 2009; Matvienko, Lewis, & Schafer, 2001; Sallis et al., 1999; Skinner, 1991). Thus, overall, T2D research has neglected the college student population in studying the relationship between risk factor knowledge and preventive health behavior.

**Theoretical Rationale**

The HBM was proposed by a team of social psychologists in the 1950s to explain participation in preventive health behaviors (Hockbaum, 1958; Kegeles, Kirscht, Haefner, & Rosenstock, 1965; Rosenstock, 1960, 1966, 1974). The United States was experiencing a health crisis associated with too few physicians and high healthcare costs, which resulted in insufficient treatment of patients (Voices From the Past, 2004). The idea of disease prevention was introduced to reduce the number of patients who needed to see a physician, so cost and treatment levels could return to their original levels. The HBM is used as a tool to predict why, or why not, an individual took part in preventive behaviors associated with disease prevention (Rosenstock, 1966).

Rosenstock and colleagues initially developed the HBM to predict single behavior change actions such as being vaccinated (Pender, 1982, 2006). Although prediction of a single behavior change was essential at the time due to the outbreaks such as tuberculosis, the model was not used as a tool for predicting long term health behavior.
changes that require daily compliance, such as participation in physical activity and eating healthy foods (Pender, 1982, 2006).

**Constructs.** The constructs of the HBM are all dependent on the individual’s beliefs that the behavior change will result in something of value to them (Rosenstock, 1966). For example, a desire to avoid illness to regain health status may be of value to some people.

The five original constructs all relate to personal beliefs for behavior change: perceived benefits, perceived barriers, perceived susceptibility, perceived seriousness, and perceived threat (Rosenstock, 1974). Perceived benefits and barriers to preventive action directly impact behavior change. Perceived benefits are the individual’s beliefs of whether this impact is intrinsically positive or negative (Janz & Becker, 1984). If it is intrinsically positive, or highly beneficial to them, then the behavior is more likely to occur than if the individual views the impact as less positive. Perceived barriers are the obstacles that must be overcome to make a successful behavior change. Perceived barriers must be taken into account, because they could be obstacles when making changes in behavior that could outweigh the positive benefits (Rosenstock, 1974).

Together, perceived susceptibility to a disease and perceived seriousness of a disease contribute to perceived threat of a disease (Becker et al., 1974). Perceived susceptibility is the belief of how likely it is someone will get the disease, while perceived seriousness is how severely they believe the disease will affect them. According to the HBM, the greater the perceived susceptibility and severity are, the higher perceived threat is, and the more likely it is that the recommended behavior
change will occur (Janz & Becker, 1984). Perceived threat acts as a central construct to bridge beliefs and action.

In addition to the five constructs in the HBM, Figure 1.1 also identifies several modifying factors that may increase perceived threat of disease.


These modifying variables include: cues to action, demographics, sociopsychological variables, and structural variables (Becker et al., 1974). Cues to action are strategies used to activate behaviors and are usually environmental, such as smoking cessation billboards, or postcard reminders from the dentist for an appointment. Demographic variables include age, sex, race, and ethnicity. Examples of sociopsychological variables are personality, social class, and peer and reference group
pressures. Structural variables are knowledge about disease and prior contact with disease (Rosenstock, 1974).

As seen in Figure 1.1, all modifying variables directly impact perceived threat (Becker et al., 1974). With the exception of cues to action, the other modifying variables may also directly affect perceived susceptibility, perceived seriousness, perceived benefits, and perceived barriers to preventive action. Thus, in the HBM, cues to action is limited in its effects on behavior change (via perceived threat only), while various demographic, sociopsychologic, and structural variables have much more influence due to their additional relationships with the constructs (Becker et al., 1974).

**Impact on research.** In the present study, the constructs and variables from the HBM guide the research. More specifically, this research examines college students’ knowledge of T2D risk factors, and how this knowledge is related to the individuals’ perceived seriousness, susceptibility, barriers to action, and benefits of action in the context of health behaviors. Cues to action and self-efficacy were not the focus of the research, because there is no evidence that they are impacted by knowledge.

Knowledge is an important variable, because it is the basis for the perceived seriousness, susceptibility, barriers to action, and benefits of action (Becker et al., 1974). Yet there has been little research with a primary focus on knowledge when implementing the HBM and none that sampled a college student population (Abbaszadeh, Borhani, & Asadi, 2011; Alidosti et al., 2012; Ghodsbin, Zare, Jahanbin, Ariafar, & Keshavarzi, 2014; Jones, Weaver, Grimley, Appel, & Ard, 2006; Sharifirad, Entezari, Kamran, & Azadbakht, 2009).
Knowledge is a necessary pre-condition for the individual perception constructs (susceptibility and seriousness) (Becker et al., 1974). Individual perceptions, perceived susceptibility and perceived seriousness, cannot be influenced without prior knowledge. Without knowledge of the risk factors associated with type 2 diabetes (obesity, genetics, and hypertension), it is unlikely that someone would feel they are at great risk or be aware of the severity of the associated complications (heart attack, stroke, amputation, and premature death). When perceived susceptibility and seriousness are low, the likelihood of taking preventive action is not expected (Rosenstock, 1974).

The constructs of perceived benefits and barriers are also influenced by knowledge (Becker et al., 1974). The ability to calculate if the benefits outweigh barriers can only be accomplished if you have knowledge of what each of these constructs encompasses. For example, a perceived benefit of taking preventive action is that you will decrease risk of stroke, which, in turn, will decrease risk of premature death. A barrier may be the inconvenience of exercising regularly, or time cost. The likelihood of behavior increases only when the value in avoiding premature death is perceived to be higher than the inconvenience of exercising. Knowledge is an essential component to identifying both risks and ways to reduce risk (Becker et al., 1974).

The HBM predicts the likelihood of individuals to take action in preventing disease and illness (Rosenstock, 1974). More specifically, knowledge is recognized as a variable that would increase the likelihood of increasing action. This research investigates the relationship between college students’ knowledge and their likelihood of taking action to prevent T2D.
Statement of Purpose

The purpose of this study was to investigate the impact knowledge has on behaviors. Knowledge regarding disease may be essential before an individual can make lifestyle behavior changes to minimize risk and prevent diseases, such as T2D. Knowledge related to T2D includes the nature of T2D, disease symptoms, disease risk factors, management/treatment of T2D, and disease complications.

In addition to identifying knowledge, it is also important to recognize the types of positive health behaviors in which the individual participates. Behaviors related to T2D include, but are not limited to, maintaining a healthy diet and participation in physical activity. The specifics regarding diet and physical activity behaviors are vast and include information that may not be available to all populations.

Hypotheses and Research Questions

The hypotheses for this study were as follows:

H 1: There is a statistically significant positive correlation between the level of diabetes knowledge and the frequency of physical activity in current college students between the ages of 18-24.

The following research questions were addressed:

1.1 Based on the Knowledge of Risks for Developing Type 2 Diabetes Scale and a closed-ended diabetes knowledge questionnaire, in undergraduate students between the ages of 18-24, what is the current level of knowledge related to the risk factors for and problems related to T2D?
1.2 Based on the Youth Risk Behavior Surveillance Survey (YRBSS), what is the frequency of physical activity of current undergraduate college students, between the ages of 18-24?

1.3 Using Spearman’s rank correlation analysis, is there a significant positive correlation between level of diabetes knowledge and the frequency of physical activity in current college students between the ages of 18-24?

H 2: There is a statistically significant negative correlation between the level of diabetes knowledge and the consumption frequency of high-sugar and high-fat foods in current undergraduate college students between the ages of 18-24.

The following research questions were addressed:

2.1 Based on the Knowledge of Risks for Developing Type 2 Diabetes Scale and a closed-ended diabetes knowledge questionnaire, in undergraduate students, between the ages of 18-24, what is the current level of knowledge related to the risk factors for and problems related to T2D?

2.2 Based on the 2012 Youth Adolescent Food Frequency Questionnaire, how often is high-sugar food consumed by current undergraduate college students between the ages of 18-24?

2.3 Based on the 2012 Youth Adolescent Food Frequency Questionnaire, how often is high-fat food consumed by current undergraduate college students between the ages of 18-24?
2.4 Using Spearman’s rank correlation analysis, is there a significant negative correlation between level of diabetes knowledge and the consumption frequency of high-sugar foods by current undergraduate college students between the ages of 18-24?

2.5 Using Spearman’s rank correlation analysis, is there a significant negative correlation between level of diabetes knowledge and the consumption frequency of high-fat foods by current undergraduate college students between the ages of 18-24?

2.6 Using Spearman’s rank correlation analysis, is there a significant negative correlation between level of diabetes knowledge and the consumption frequency of high-sugar and high-fat foods, or junk foods, in current undergraduate college students between the ages of 18-24?

**Significance of the Study**

This research will enhance the current knowledge set regarding disease prevention strategies. More specifically this study will help us to better understand if knowledge has any impact on preventive health behaviors of college students. College students are the population of interest due to the freedom they have to make life choices. Some of these choices include preventive health behaviors such as appropriate nutrition and physical activity.

If individuals are more knowledgeable regarding disease prevention behaviors then it would be expected that they will participate in more positive health behaviors. More positive health behaviors are expected because they will want to minimize their risk of disease and have a high QOL (Rosenstock, 1974). If perceived benefits of action
outweigh the barriers, and perceived susceptibility and seriousness are high, it will be more likely that individuals will participate in preventive behaviors. If disease knowledge does impact preventative behavior, then we can begin to implement education services specifically designed to target behaviors related to T2D risk.

T2D is a growing epidemic worldwide. It is not only prevalent in older adults, but the incidence rates have increased in children (NDS, 2014). It is essential to understand why the number of diagnosed cases is rising so quickly. Therefore the target population for this study are younger populations; more specifically, college aged students.

Poor health behaviors have been associated with an increased susceptibility to T2D (NDS, 2014). Research shows that disease and prevention knowledge does improve various positive health behaviors (Fletcher et al., 1989; Jayanti & Burns, 2009; Laiho et al., 1991; LeClair et al., 2009, 2010; Petosa and Jackson, 1991). There is also a research base that discusses knowledge related to specific behaviors such as nutrition and physical activity (Abood, Black, & Birnbaum, 2004; Avis, McKinlay, & Smith, 1990; Boeckner, Kohn, & Roskwell, 1990; Franko et al., 2008; Ha & Caine-Bish 2009; Ha, Caine-Bish, Holloman, & Lowry-Gordon, 2009; Ha & Caine-Bish 2011; Hivert, Langlois, Berard, Cuerrier, & Carpentier, 2007; Howze, Smith, & DiGilio, 1989; Kolodinsky, Harvey-Berino, Berlin, Johnson, & Reynolds, 2007; Krešić, Jovanović, Žeželj, Cvjanović, & Ivezic, 2009; Matvienko, Lewis, & Schafer, 2001; Tamirat, Abebe, & Kirose, 2014; Sallis et al., 1999; Skinner, 1991). There is a lack of literature regarding college students’ knowledge of risk factors related to T2D and how knowledge may impact on the health behaviors.
Not only will college students be able to benefit from the information gained from this study, but so can parents. Parents must be aware of positive health behaviors so they can model them, then teach them to their children. Parents can also teach their children about the risk factors related to disease and prevention. If parents understand that knowledge may be the first step in disease prevention, they may be more likely to teach appropriate knowledge to their children.

Colleges can also benefit from the content of this study. When it comes to policy development, colleges must be aware of the impact knowledge has on student behavior. If knowledge does impact student behavior, programs can be put into place to improve student knowledge related to preventive behaviors, specifically nutrition and physical activity. This is especially important for underrepresented populations that are increasing on campuses who may not have the economic funds to treat illness now or in the future. It is important to equip them with the knowledge resources now so they can prevent future disease.

This study investigated the current knowledge of college students related to the risk factors of T2D. This study also evaluated the health behaviors of the college students that may impact their risk, such as nutrition and physical activity. Ultimately, the data were analyzed to identify a correlation between the variables of knowledge and health behaviors of T2D.

**Definition of Terms**

*College Student* is defined as any full-time undergraduate student between the ages of 18 and 24 who lives on campus.
Health Behavior is defined as any “activity undertaken by a person who believes himself to be healthy, for the purpose of preventing disease or detecting disease in an asymptomatic stage” (Kasl and Cobb, 1966, p. 246).

Health Belief Model is defined as an intrapersonal theory that predicts health behavior change through individual perceptions, modifying variables, and the likelihood of action.

Incidence is the number of new cases of disease or illness in a population. Generally, a rapid increase is discussed (Ibrahim, 1999).

Knowledge is the degree to which an individual possesses the knowledge related to a specific health condition, its risk factors, and preventive measures.

Perceived Barriers to action are defined as the physical and psychological obstacles that may hinder or delay the desired outcome, such as cost, side effects, pain, inconvenience, etc. (Janz & Becker, 1984). The desired outcome would be behavior change to prevent disease. Perceived barriers to action include time and economic cost of the behavior, and well as a change in normal routine. The greater the barriers, the less likely behavior change will occur.

Perceived Benefits of action are defined as the individual’s idea of how likely it is that their action will result in what they believe to be a positive outcome, such as ability to reduce risk of the disease (Janz & Becker, 1984). Perceived benefits of action include improved QOL and longevity. The greater the perceived benefits, the more likely a behavior change will occur.

Perceived Seriousness of disease is what an individual believes about the effects of the condition on themselves. Perceived seriousness is related to the symptoms
associated with the disease. For T2D this could be vision impairment, amputation, and neurologic disorder. The higher the perceived seriousness, the more likely a behavior change will occur.

*Perceived Susceptibility* of disease is the belief of risk of contracting a specific disease, the belief that one is in danger (Rosenstock, 1974). Perceived susceptibility for T2D may be increase when an individual has a family history of T2D. The higher the individual’s perceived susceptibility is, the more likely it is that a behavior change will occur.

*Prevalence* considers old and new cases associated with disease and illness. It takes the total number of existing cases into account (Ibrahim, 1999)

*Prevention* consists of three levels. Primary and secondary prevention are actions taken prior to diagnosis to reduce serious risk, while tertiary prevention occurs after diagnosis (Shamansky & Clausen, 1980). Primary and secondary prevention protects against the occurrence of specific diseases though immunizations, reducing risk factors though physical activity, good nutrition, and screenings for early detection. In this paper, prevention only refers to primary and secondary preventive measures.

*Risk Factors* are behaviors and conditions that increase the likelihood of disease and illness. In relation to T2D, risk factors can be non-modifiable or modifiable. This study will focus on modifiable risk factors, such as diet and participation in physical activity.

*Type 2 diabetes* is defined as a condition when initially the body does not respond to the insulin correctly to metabolize glucose; if left unchecked, the disease progresses, and the body cannot produce enough insulin. Lack of response to insulin results in
increased blood glucose levels, which acts as a signal for the pancreas to continue to produce more insulin. This continuous signaling overworks the beta cells of the pancreas, and leads to cell death. Over time, the pancreas of a type 2 diabetic functions as a type 1 diabetic and insulin supplementation is required.

**Chapter Summary**

Overall, T2D is a growing problem worldwide. It is important to improve the knowledge base regarding prevention of T2D to begin to limit the incidences. The HBM is a tool that can help identify the perceptions that influence participation in health behaviors. More specifically, the variable of knowledge, a modifying variable at the core of the model, may be the key factor for improving positive health behaviors related to T2D.

The next chapter discusses diabetes and its effects on the body. The section also discusses the HBM and the importance of the knowledge variable that is being investigated in the current study. Finally, the following chapter will review literature that investigates knowledge as a predictor for participation in positive health behaviors.

Chapter 3 will discuss the methodology the researcher implemented in this study, including the research context, participants, instrumentation, and data analysis procedures. Chapter 4 will identify any major findings. Chapter 5 will discuss the implications to the findings, any limitations, and recommendations for further research.
Chapter 2: Review of the Literature

Introduction and Purpose

This chapter will examine literature relevant to the importance of knowledge as a predictor of behavior. The review begins with an overview of diabetes and its physiological effects on the body. Second, a discussion of the health belief model (HBM) will be presented including an overview of the theory and its historical context. Then a comprehensive review of the constructs will be presented with a focus on the variable of knowledge, a modifying variable. Knowledge is presented as the antecedent to behavior change. Finally, two other modifying variables, demographics and sociopsychologic aspects, will be discussed in relation to their impact on behavior change.

Diabetes

Diabetes is a general term used to describe insulin resistance and the body’s inability to stimulate uptake of glucose. In the United States, 29.1 million people have been diagnosed with diabetes (NDS, 2014). When a healthy individual consumes food with sugar, or glucose, the pancreas responds by producing insulin. Insulin activates GLUT 4 to translocate from intracellular sites to the cell surface (Pessin & Saltiel, 2000; Pessin, Thurmond, Elmendorf, Coker, & Okada, 1999). This signals the cell to open, allowing glucose to enter the cells so it can be metabolized. Blood glucose levels then return to normal. In the case of a diabetic patient, if the pancreatic cells do not secrete
insulin, then cells cannot take in glucose, so blood glucose levels remain high, and the cells lack nutrients (Pessin & Saltiel, 2000).

**Type 1 vs. type 2 diabetes.** There are two types of diabetes, type 1 and type 2 diabetes. Type 1 diabetes (T1D) is a result of an autoimmune disorder onset in childhood. T1D accounts for about 5-10% of all cases of diabetes. In an individual with T1D, the body’s immune system attacks its own pancreatic cells, leading to cell death. This can limit or completely eliminate the pancreas’ ability to produce and secrete insulin. Therefore, glucose cannot enter the cell to be metabolized. Individuals diagnosed with T1D must inject insulin to aid in the metabolic process (NDS, 2014).

Type 2 diabetes (T2D) accounts for 90-95% of all diabetes cases; it may be the result of lifestyle behaviors and is generally onset in late adulthood (NDS, 2014). T2D generally begins with insulin insensitivity, which evolves when there is an overabundance of glucose and the pancreas continually secretes insulin. The overabundance of glucose is usually due to poor lifestyle behaviors such as a diet high in carbohydrates and/or fat (NDS, 2014).

Overconsumption of carbohydrates and fats has been shown to interfere with insulin signaling pathways and contribute to T2D (Saltiel & Kahn, 2001; Storlien, Kraegen, Jenkins, Chisholm, 1988). When a healthy individual consumes carbohydrates, the body digests them into glucose. As discussed before, carbohydrate intake would signal a response to the pancreas to secrete insulin, and the glucose would be delivered into the cell for use. When high amounts of carbohydrates are consumed, the glucose is constantly signaling the pancreas to secrete insulin. This constant signaling overworks the pancreas and, over years, leads to pancreatic beta cell death. When enough of the
pancreatic cells die, insulin cannot be secreted, leading to a condition similar to T1D (Saltiel & Kahn, 2001; Storlien, Kraegen, Jenkins, Chisholm, 1988).

Diets high in fat also contribute to insulin resistance (Maegawa, Kobayashi, Ishibashi, Takata, & Shigeta, 1986; Thorburn, Storlien, Jenkins, Khouri, & Krargen, 1989). When a healthy individual consumes fat, the body metabolizes it and uses it for energy. When an individual consumes high levels of fat in their diet, the fat molecules can bind to the insulin receptors on the cell, blocking the insulin from binding. Since insulin cannot bind, GLUT4 cannot be translocated and the glucose receptors remain closed. With a closed cell, glucose cannot be absorbed, and it continues to remain in the blood. While glucose is in the blood, it is still signaling the pancreas to produce insulin that cannot be used due to the blocked receptors on the cell. Over years, this too can lead to beta cell death in the pancreas (Maegawa, Kobayashi, Ishibashi, Takata, & Shigeta, 1986; Thorburn, Storlien, Jenkins, Khouri, & Krargen, 1989).

Complications associated with T2D. Overall, after extended periods of uncontrolled diabetes, the QOL of a diabetic individual is impaired (Goldney, Fisher, Phillips, & Wilson, 2004; Kiadaliri, Najafi, & Mirmalwek-Sani, 2013). This impaired QOL is a result of the complications associated with T2D. These complications include hypertension, obesity, cardiovascular disease, stroke, kidney disease, blindness, amputations, depression, nerve disease, and premature death (Goldney et al., 2004; NDS, 2014).

Most of the complications associated with T2D can be prevented and/or alleviated with good glucose control (Hu et al., 2001; NDS, 2014). Diet and exercise have been found to be two lifestyle behaviors that can limit incidence rates of T2D (Helmrich,
Ragland, Leung, & Paffenbarger, 1991; Lindstrom et al., 2003). Other studies discuss improving insulin sensitivity through the activation of more GLUT4 (Goodyear et al., 1990; Hansen, Nolte, Chen, Holloszy, 1998). These studies examined exercised and sedentary rats, concluding that exercise increases the amount of GLUT4 that is translocated to the cell surface. Higher GLUT4 levels allow the cell to uptake more glucose. There are also studies that investigate the effects of diet and exercise interventions on insulin sensitivity (Goodyear et al., 1990; Hansen, Nolte, Chen, Holloszy, 1998). These interventions can postpone the onset of T2D and/or improve the physiological effects that are coupled with diagnosis of T2D (Goodyear et al., 1990; Hansen, Nolte, Chen, Holloszy, 1998).

**Interventions to combat T2D.** Although the complications associated with T2D can be severe, there are interventions, or behaviors, that have been associated with minimizing the detrimental effects of the disease by reducing insulin resistance (American Diabetes Association, 1998). These behaviors include physical activity and dietary control. Many studies have examined the effects of exercise on improving insulin sensitivity through physical activity in pre-diabetics and T2D adults (Arciero, Vukovich, Holloszy, Racette, & Kohrt, 1999; Cox, Burke, Morton, Beilin, & Puddey, 2004; Trovati et al., 1984; Winnick et al., 2008; Yamanouchi et al., 1995).

**Pre-diabetic adults.** Pre-diabetic adults generally exhibit symptoms of obesity and impaired glucose tolerance (IGT) that put them at greater risk for T2D. Many studies investigate lifestyle changes to improve these symptoms to minimize risk of T2D (Arciero et al., 1999; Cox, et al., 2004). Other studies examined improvement of
symptoms in T2D patients (Trovati et al., 1984; Winnick et al., 2008; Yamanouchi et al., 1995).

Arciero, Vukovich, Holloszy, Racette, and Kohrt (1999) compared short term diet and exercise on insulin action in IGT subjects. IGT subjects are defined as having a blood glucose level between 140 and 199 mg/dl of blood following an oral glucose tolerance test. Sixteen subjects (n=9 males; n=7 females) with an average age of 53±1 years were chosen for obesity and sedentary lifestyles. All women were post-menopausal (Arciero et al., 1999).

Subjects were randomized into low-calorie diet (LCD, n=8) and exercise training groups (ET, n=8) for a 10 day intervention. All subjects were provided with meals for the term of the intervention. The LCD group consisted of 50% of the calories required to maintain energy balance. The LCD subjects’ diets consisted of 35% good protein, 50% carbohydrates, and 15% fats. LCD subjects were administered 1.5 g protein/kg fat free mass and a minimum of 150 g of complex carbohydrates for the entire intervention. Subjects in the ET maintained their normal energy intake with the prepared meals. ET subjects also participated in 50-60 minutes of supervised exercise daily for 10 days. The first and last ten minutes of the session were a warm-up and cool-down. The 50 minutes of exercise consisted of walking, jogging, cycle ergometry, rowing ergometry, and/or simulated cross-country skiing at an intensity of 60-65% of their VO$_{2}$max (Arciero et al., 1999).

Pre and post-intervention measures of body weight, fat free mass, VO$_{2}$max, fasting plasma glucose (FPG), fasting plasma insulin (FPI), insulin activity, and glucose disposal rate were taken. Body composition was measured with hydrodensitometry. FPG levels
were measured using the glucose oxidase method and FPI levels were measured with double-antibody radioimmunoassay. Insulin activity and glucose disposal rate were analyzed using the hyperglycemic clamp procedure. This procedure consisted of 15-120 minutes of sustained hyperglycemia (Arciero et al., 1999).

The data were analyzed using repeated measures analysis of variance (ANOVA) focusing on the group by time intervention effect. Regression equations were developed for the glucose disposal rates relative to the plasma insulin concentrations for each treatment group. The slopes and intercepts of the lines were compared using \( t \)-statistics. Significance was set at \( p<0.05 \) (Arciero et al., 1999).

As expected, results indicated positive trends for both intervention groups related to all variables. Body weight and fat mass significantly decreased in both the LCD group (-4.1±1.7 and -3.4±1.0 kg, respectively) and the ET group (-1.4±0.3 and -1.1±0.8 kg, respectively), although decreases were significantly greater in the LCD group than the ET group. In the ET group a 7% increase in VO\(_{2\text{max}}\) was achieved (35.1±3.3 to 37.7±3.0 ml·min\(^{-1}\)·kg FFM\(^{-1}\)). FPG and FPI levels significantly decreased in the LCD (115±10 to 99±4 mg/dl and 23.9±5.6 to 15.2±3.9 µU/ml) and ET (112±4 to 101±5 mg/dl and 17.6±1.9 to 13.9±2.4 µU/ml) groups (Arciero et al., 1999).

Changes and differences between groups regarding insulin and glucose activity were also significant. A decrease in insulin response of 46% was detected in response to the hyperglycemia at 0-10 minutes in the ET group and 21% in the LCD group. At 10-45 minutes of hyperglycemia subjects in the ET group experienced a 33% decrease in insulin, and subjects in the LCD group experienced a 41% decrease in insulin levels. Glucose disposal rate showed significant improvements at 75-120 minutes for both
groups. Subjects in the ET group increased their glucose disposal rate by 55% and subjects in the LCD group improved by 35% (Arciero et al., 1999).

Another study investigated the effects of a 16 week program on FPG, insulin activity, and glucose disposal rates of at-risk subjects (Cox et al., 2004). The purpose of the study was to examine the independent and combined effects of a diet and exercise intervention on glucose and insulin levels. Sixty overweight, sedentary men between 20 and 50 years of age were recruited for the study (Cox et al., 2004).

Baseline and post-intervention measures for all subjects included usual dietary intake with a 3 day recall, fitness level, body weight, body fat, plasma glucose levels, and plasma insulin levels. Subjects were randomized into one of four groups. Two of the groups maintained their normal calorie intake (NE), while the other two groups were put on a low calorie diet (LE). The LE diets were individualized for each subject in the group. In general, LE group reduced energy intake by 1,000 to 15,000 kcal per day, consisting of 15% protein, 30% fat and 55% carbohydrates. The two NE and two LE groups were further divided into light activity (LA) and vigorous activity (VA). The LA control group participated in slow flexibility exercises one time per week and stationary cycling with zero resistance two times per week for 30 minutes. The VA group participated in stationary cycling three times a week for 30 minutes at 60-70% of their maximum workload (Cox et al., 2004).

The data were analyzed using Bonferroni paired t-tests for within-group comparisons of baseline versus post-intervention measures. Changes in glucose and insulin were analyzed using two-factor ANOVA for diet and exercise. Results indicated an increase in mean $V_{O2max}$ from baseline of 24% in the both VA groups (0.56 L/min;
0.47, 0.65 L/min). Diet did not impact fitness level. Compared to the NE groups, mean body mass and body fat significantly decreased in the LE groups (x: 10.12 kg; 95% CI: 8.02, 12.22 kg; \( p < 0.001 \)). Exercise did not significantly impact body composition.

Plasma glucose and plasma insulin levels improved in all groups. Mean fasting plasma glucose was significantly lower in the VA groups [0.30 (0.06, 0.54 mmol/L; \( p < 0.02 \)] lower] than the LA groups, which indicated that exercise has a direct effect on glucose levels. Exercise did not have a significant effect on insulin levels, although a trend for reduction was present (Cox et al., 2004).

**T2D adults.** Once diagnosed with T2D, management of the effects becomes the individual’s only option. It is important to improve insulin sensitivity and restore healthy blood glucose levels. The following studies investigate the effects of exercise and diet on insulin and glucose levels of T2D subjects (Trovati et al., 1984; Winnick et al., 2008).

Trovati et al. (1984) examined the effects of moderate daily exercise on insulin action and glucose tolerance in five male T2D subjects (54±4 years). All subjects had T2D for five years, were sedentary, weighed 115±7% of ideal body weight and had a fasting plasma glucose level greater than 200 mg/dl (Trovati et al., 1984).

Pre and post-intervention measures of VO\(_{2\text{max}}\), plasma glucose, and oral glucose tolerance were conducted. The plasma glucose was measured using an enzymatic method. The oral glucose tolerance test consisted of ingesting 75 g glucose and obtaining serial venous blood samples every 30 minutes for 120 minutes. Subjects also participated in a six week exercise intervention. The exercise intervention consisted of 60 minutes of exercise on the cycle ergometer seven times a week at 50-60% of VO\(_{2\text{max}}\). Subjects were
instructed to increase their daily energy intake by 400 kcal. The data were analyzed using student’s t test for paired data with significance set at \( p < 0.05 \) (Trovati et al., 1984).

All subjects showed improvement in their fitness, glucose, and insulin levels following the intervention. \( \text{VO}_2\text{max} \) improved significantly for all subjects by 15\% (2,018±98 ml/min to 2,342±107 ml/min). Plasma glucose decreased in all subjects from 11,761±192 mg/dl/min to 11,257±404 mg/dl/min. Similar trends were also seen in plasma insulin but only for three subjects. Fasting plasma glucose significantly decreased in all subjects (157± 13 mg/dl to 147±13 mg/dl) (Trovati et al., 1984).

Another study investigated the effects of exercise on insulin sensitivity, both in the plasma and whole body (Winnick et al., 2008). The purpose of this study was to determine the impact of a 7 day aerobic exercise regimen on insulin sensitivity in T2D adults. Eighteen sedentary T2D subjects, (5 males and 13 females) between the ages of 30 and 60 years, were recruited for the study (Winnick et al., 2008).

The subjects were randomly assigned to either an energy balance group (EB) or energy balanced with exercise group (EBE). Both groups consumed a diet of 50\% carbohydrates, 30\% fat, and 20\% protein for 15 days. During the last 7 days, the EBE group participated in an exercise regimen. On days 1 through 3 and 5 through 7 of the exercise regimen, subjects participated in two 25 minute bouts of aerobic exercise at 70\% of their \( \text{VO}_2\text{max} \), with a 10 minute break in between. The exercise was walking on a treadmill. On day 4, subjects participated in one 60 minute bout of exercise at 60\% of their age predicted maximum heart rate (Winnick et al., 2008).

Pre- and post-intervention measures that were taken included body fat, \( \text{VO}_2\text{max} \), and insulin sensitivity. Body fat was measured with bioelectrical impedance analysis and
VO2max was determined with 12 lead electrocardiogram monitoring. The isoglycemic clamp was used to measure insulin sensitivity through plasma samples at 90, 210, and 330 minutes of the protocol. Repeated measures ANOVA evaluated group by time by insulin infusion rate interactions during the clamp to investigate differences in insulin sensitivity between the groups at varying times. Body fat and VO2max were assessed using group by time interactions. Significance was set at $p<0.05$ (Winnick et al., 2008).

Analysis revealed many responses to diet and exercise for body fat, VO2max, and insulin sensitivity. Both groups, EBE and EB, demonstrated a trend for a decrease in body fat. At baseline, the EBE group was at 39.5±2.3% and the EB group was at 43.0±2.0%. Post-intervention, the EB group’s body fat decreased to 38.9%±2.4% and the EBE group to 42.6%±2.0%. VO2max also changed in both groups, but it was not significant and actually slightly worse in the EBE group: The EB group went from 20.4±1.7 ml/kg·min to 21.5±1.9 ml/kg·min and the EBE group went from 22.6±1.2 ml/kg·min to 22.1±1.2 ml/kg·min (Winnick et al., 2008).

In relation to plasma insulin and plasma glucose, there were also no significant changes were detected at 90, 120, and 330 minutes of the clamp procedure. In both groups, plasma insulin levels improved. In the EB, at baseline, group plasma insulin levels for these time points were 16±4, 34±4, and 69±5 µU/ml and at post-intervention they were 15±4, 32±3, and 64±3 µU/ml. In the EBE group, at baseline, plasma insulin levels for these time points were 15±2, 38±2, and 65±4 µU/ml and at post-intervention they were 13±2, 30±2, and 59±2 µU/ml. Glucose activity increased slightly in the EB and EBE groups. At baseline, the glucose activity levels of EB at the time points were 2,254±134; 2,273±118; 2,297±150 dpm/mg and at post-intervention were 2,356±1,131;
2,334±150; 2,382±197 dpm/mg. In the EBE group, at baseline, glucose activity levels for the time points were 2,237±86; 2,198±111; 2,209±113 dpm/mg and at post-intervention 2,273±202; 2,107±127; 2,053±67 dpm/mg (Winnick et al., 2008).

Whole body insulin sensitivity was also measured, and significant differences between groups were identified. At post-intervention, the EB group’s average whole body insulin sensitivity was 0.10±0.02 mg/kg·min, and the EBE group’s average whole body insulin sensitivity was 0.16±0.3 mg/kg·min (Winnick et al., 2008).

From the previous research, trends were detected that indicate diet and exercise may play key roles in preventing and controlling T2D. Both of these variables related to behaviors that the individual must adopt to improve their disease risk and maintain their QOL. The behavior change process is quite extensive and relies on several intrinsic and extrinsic factors. The health belief model (HBM) is one example of a theory that predicts behavior change and it focuses on behavior change to improve or prevent specific health conditions.

**Theory: Health Belief Model**

The HBM is an intra-personal, value-expectancy, behavior change theory (Janz, Champion, & Strecher, 2002). This model is commonly used in reference to the prediction of health-related behavior change in response to the worth of maintaining health status. More commonly, this model has been used to predict how likely one is to modify their own unhealthy behaviors to improve their disease risk and maintain QOL (Janz, Champion, & Strecher, 2002).

**Historical context.** The HBM was proposed in the 1950s by a group of social psychologists from the United States Public Health Service in response to the limited use
of health services as a form of disease prevention (Hockbaum, 1958; Kegeles, Kirsch, Haefner, & Rosenstock, 1965; Rosenstock, 1960, 1966, & 1974). The HBM was generated to explore the health behaviors of individuals free from illness and disease. It sought to explain why healthy people continued to participate in positive health behaviors to remain in their current healthy state, and why others fail to take preventive action (Rosenstock, 1966). Kasl and Cobb (1966) defined positive health behavior as any “activity undertaken by a person who believes himself to be healthy, for the purpose of preventing disease or detecting disease in an asymptomatic stage” (p. 246).

Prior to 1950, in the United States, there had been a major emphasis on treating communicable diseases (Voices From the Past, 2004). Throughout the 1950s, the United States experienced a deficit in doctors, and patients were not being treated. By the 1960s, the cost of health care doubled, so it became almost impossible for the sick and elderly to afford treatment. As a result, the 1960s became a time of major concern for public health and an economic health care crisis broke out. In response to this crisis, the U.S. Public Health Service transformed their motives from disease treatment to prevention in an attempt to reduce health care costs. In the early 1970s it was well-recognized that people during this time were not taking preventive actions against disease such as screening tests, early detection of disease, and various anticipatory behaviors (Rosenstock, 1974).

When the HBM was first introduced in 1974, anticipatory behaviors were intended to be a single behavioral action such as receiving an immunization (Pender, 2006; Rosenstock, 1974). The HBM was offered by the U.S. Public Health Service as a screening tool to explain why preventive measures for tuberculosis (Hochbaum, 1958) and cervical cancer (Kegeles et al., 1965) were not successful, even though they were
free. After implementing the HBM, preventive behaviors, such as vaccinations and screenings, became required with long term commitments. Over time, adopted lifestyle modifications have included smoking cessation, safe sexual practices, proper nutrition, and increased physical activity participation (Pender, 1982, 2006). These positive health behaviors were promoted in order to reduce the number of patients’ visits to offices and clinics, thus reduce healthcare costs (Pender, 1982, 2006).

Prevention is important for all individuals to minimize the occurrence of disease and its progressing complications (Pender, 1982). The longer an individual is unaware of a medical condition and does not take action to maintain health, there is a greater disease risk (Pender, 1982).

The HBM offers a means to predict what motivates a healthy person to take preventive measures (Pender, 2006). Once these motivational characteristics are identified, it makes it possible to predict who will, and will not, perform the preventive behaviors. This information can be used to create and implement interventions to increase the number of individuals participating in preventive behaviors (Pender, 2006).

**Origins.** When developing the HBM, Rosenstock and colleagues were interested in theory, rather than problem-solving. During the time in which the HBM was initiated into practice, there were few behavioral scientists involved in health research (Rosenstock, 1974). The theories that support the HBM were not developed as health behavior theories, but as behavior theories that were later applied to situations in the health field (Rosenstock, 1974).

As noted in Table 2.1, the HBM has origins that date back to social-psychological work by Lewin et al. (1944). Lewin proposed that every person lives in an environment
composed of “valence regions.” Conceptually linked to regions of influence between multiple atoms in molecule formation, valence regions in the human environment can increase positively, increase negatively, or have a neutral influence upon a given person’s health behaviors. In relation to health, negative valence regions could be considered exposure to unhealthy behaviors, while positive valence regions involve exposure to beneficial behaviors that help minimize and avoid the negative regions. Neutral regions have little to no value to the individual, so they have no impact. It has been theorized that we are in constant struggle, repelling our negative valence through constant seeking of positive valences that we value most (Lewin, Dembo, Festinger, & Sears, 1944). Ultimately, avoidance of negative valence and seeking positive valence, is to avoid disease and illness.

Lewin, at al. (1944), continued to hypothesize that behavior is dependent on perceived value of the outcome and perceived likelihood of the outcome as displayed in Table 2.1. If an individual perceives more value in a given area, and they believe the likelihood of the outcome is possible, they are more likely to exert energy participating in the action to promote that outcome. For example, if an individual has a desire to remain in a healthy state because they are aware of the associated negative outcomes of a disease state, due to past experience or encounters with unhealthy individuals, they will value disease prevention. The individual must also be confident that the positive behaviors can minimize risk of the disease. Only when both of these are present will there be a high likelihood of preventive action, and positive valence will outweigh the negative valence region (Lewin, at al., 1944).
Table 2.1

*Timeline of the Health Belief Model*

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Significance</th>
</tr>
</thead>
</table>
| 1944 | Lewin et al.    | • Individuals are constantly involved in valence regions to avoid illness and disease  
• Perceived value of the outcome leads to behavior change  
• Confidence in ability to minimize risk leads to behavior change  
• Behavior-Motivation Theory |
| 1950 | Rosenstock et al.| • Health belief model (HBM) (see Figure 1.1)  
• Used to assess use of one time medical screening and vaccinations |
| 1960 | Rosenstock et al.| • Motivation became a topic of consideration for the model |
| 1966 | Rosenstock et al.| • Cues to action are discussed as a modifying variable to HBM |
| 1974 | Becker et al.   | • Demographic, sociopsychological, and structural variables were incorporated into the HBM as modifying variables  
• Transition from short-term treatments to long-term preventive lifestyle behaviors  
• First consideration of motivation as a primary variable that directly impacts behavior change in the HBM  
• Reformulated HBM (Appendix A) |
| 1975 | Becker & Maiman | • Motivation is considered a factor in compliance of behavior  
• Faith in efficacy of care is indirectly related to compliance of behavior |
| 1982 | Feather         | • Motivation to change is based on subjective value of change and subjective expectancy of achieving goal |
| 1984 | Janz & Becker   | • Self- efficacy is discussed as a piece of the HBM construct barriers |
| 1985 | Becker et al.   | • Knowledge gained by the patient from the doctor can improve likelihood of action |
| 1988 | Rosenstock et al.| • Motivation is included as an explanatory variable of the HBM  
• Self- efficacy is included as an explanatory variable of the HBM |
| 1993 | Burns           | • Expanded health belief model (EHBM) was proposed (see Appendix B) |

*Note.* A description of how the HBM has been generated, influenced, and modified over time.
Lewin’s work also set the foundation for the Expectancy Value Theory (EVT) (Feather, 1982). EVT integrated the ideas that individuals will behave a certain way if both: (a) the outcome is of value to them, and (b) if taking that specific action is likely to bring about a desired outcome (Pender, 2006). Alternatively, if the outcome is of little or no value to them, and/or they believe it is impossible to achieve, the individual will not participate in a given behavior. The motivation for behavior change is dependent on subjective value of change and subjective expectancy of achieving it. When the subjective value is high, due to current high dissatisfaction, the individual believes there is a greater benefit in achieving the goal. When the subjective expectancy is high, due to past positive experiences, the individual has a high confidence level in making the change. For example, if someone experiences a heart attack, their dissatisfaction is very high. In turn, they are motivated to make a behavior change to prevent future occurrences of health related conditions. Also, if the patient truly believes that proper nutrition and physical activity can help prevent future heart attacks, because they have been informed by health care professionals and have participated in healthy lifestyles in the past. Therefore, they see that it works and are more likely to participate in the recommended behavior (Feather, 1982).

Disease prevention is crucial to optimal QOL. There are three levels of disease prevention related to health conditions; primary, secondary, and tertiary (Shamansky & Clausen, 1980). Primary and secondary prevention are actions taken prior to diagnosis to reduce serious risk. Primary prevention protects against the occurrence of specific diseases though immunizations and reducing risk factors though physical activity and good nutrition. Secondary prevention consists of screenings for early detection through
breast and testicular self-exams, professional health care appointments, and public education. Tertiary prevention is when behavior change occurs post-diagnosis to minimize the complications associated with the disease and loss of QOL. We see that tertiary prevention works in many cases (Rosenstock, 1960).

The social-psychological work by Lewin et al. (1944) also focused on Behavior-Motivation Theory, which influenced Rosenstock’s (1960) interest in motivation for behavior change. Although behavior was believed to be influenced by level of motivation, the idea was not included in Rosenstock’s earliest model due to measurement constraints (Rosenstock, 1974). The key was to determine predictors of motivation. In the health field, it is believed that diagnosis with a disease or illness will trigger motivation toward particular positive health behaviors. For example, if diagnosed with type 2 diabetes, research shows that patients tend to make lifestyle changes to help manage the condition to minimize the negative outcomes and improve disease risk to maintain QOL (Okosun, Davis-Smith, & Seale, 2012; Tuomilehto et al., 2001). This is an example of motivation in response to diagnosis of the disease, which is a tertiary preventive response. However, it is important to understand what motivates people to take primary and secondary preventive actions, especially when they are not suffering from disease or illness yet (Rosenstock, 1960).

**Original constructs.** The HBM and its constructs are described in Figure 1.1. This model was initially implemented when precise preventive behaviors associated with specific diseases were needed. The preventive behaviors stem from motivation to take action for behavior change (Janz, Champion, & Stretcher, 2002). The earliest model was composed of five constructs: perceived susceptibility to disease, perceived severity of
disease, perceived benefits of health behavior action, perceived barriers to health behavior action, and perceived threat of disease (Janz & Becker, 1984 & Rosenstock, 1974). These constructs were dependent on the individual’s own beliefs and motivation to increase the likelihood of actions resulting in something of value. Rosenstock states (1974)

...in order for an individual to take action to avoid a disease he would need to believe (1) that he was personally susceptible to it, (2) that the occurrence of the disease would have at least moderate severity on some component of his life, and (3) that taking a particular action would in fact be beneficial by reducing its severity, and that it would not entail overcoming important psychological barriers... (p. 330)

A desire to avoid illness may produce a response of health actions to prevent the threat of that illness (Janz & Becker, 1984). Perceived threat is the likelihood of damage or danger to arise from the disease. If perceived threat is high, the individual’s likelihood to take action, or make a behavior change, is high (Janz et al., 2002; Rosenstock, 1960).

Perceived threat is crucial to the HBM, because it bridges both the modifying variables and individual perceptions to determine the likelihood of action. Perceived threat is a central concept of the model that moderates behavior change (Janz et al., 2002).

As described in Figure 1.1, perceived threat is a function of perceived susceptibility to and perceived seriousness of, or severity of, disease. Both of these constructs rely on the person’s individual beliefs, not facts (Janz et al., 2002). Perceived susceptibility is (NDS, 2014) the belief of risk of contracting the disease. Personal vulnerability to contracting the disease can include their current behaviors which may put
them at higher risk (Janz & Becker, 1984). For example, if someone is obese and has a sedentary occupation, their susceptibility to the occurrence of type 2 diabetes is high. If the individual is not aware of the association between obesity and type 2 diabetes, they would perceive zero susceptibility. When considering awareness, knowledge becomes an important modifying factor and will be discussed later (Janz & Becker, 1984).

Perceived seriousness is related to the consequences following diagnosis of the disease (Janz & Becker, 1984). For example, type 2 diabetes is correlated with cardiovascular disease, stroke, and premature death. Only when the individual is made aware of these consequences, such as receiving some knowledge from a health care specialist, will perceived severity be high. In order for an individual to feel threatened by a disease and take preventive action, both perceived susceptibility and severity must be present (Rosenstock, 1960).

Also described in Figure 1.1, perceived benefits and barriers are directly associated with the likelihood of taking action to prevent the disease or illness (Janz & Becker, 1984). Perceived benefit is the individual’s idea of how likely it is that their action will result in what they believe to be a positive outcome, such as ability to reduce risk of the disease. Perceived barriers are the physical and psychological obstacles that may hinder or delay the desired outcome, such as cost, side effects, pain, inconvenience, etc. (Janz & Becker, 1984). The higher the perceived benefits are and lower the perceived barriers are, the more likely it is for the individual to take action (Janz & Becker, 1984).

In addition to the five constructs in the HBM, Figure 1.1 also identifies several modifying factors that may increase perceived threat of disease. In Rosenstock’s (1966)
earliest work, he termed one of the influencing factors *cues to action*. Later revisions discuss additional modifying factors including demographic, sociopsychological, and structural variables (Becker, Drachman, & Kirscht, 1974). Cues to action are directly related to perceived threat and may act as a stimulus to trigger action (Janz & Becker, 1984). Cues to action can be internal or external stimuli. Internal stimuli can be body perception, symptoms, and experiencing distress, while external stimuli may include mass media communications, advice from others, and reminder postcards from a physician or dentist (Janz & Becker, 1984; Rosenstock, 1974).

Demographic, sociopsychological, and structural variables are modifying variables directly related to perceived threat, and also they directly impact the five constructs: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and perceived threat (Rosenstock, 1974). Demographic variables include age, sex, race, and ethnicity. Personality, social class, and peer and reference group pressures are examples of sociopsychological variables. Structural variables are knowledge about disease and prior contact with disease (Rosenstock, 1974). Knowledge is the primary focus of this research, due to its impact on the five major constructs, and ultimately, behavior change.

**Development over time.** Since first introduced into the literature in the 1960s, the HBM has been modified to meet the needs of the individuals and communities in which it has been practiced. The HBM was developed to increase the use of preventive medical treatments, which were low at the time (Rosenstock, 1974). Becker and colleagues have used the HBM to distinguish motives to improve positive health behavior, displayed in Table 2.1, 1974 and 1975 (Becker, 1985; Becker et al., 1974;
Becker & Maiman, 1975). Once motives were made apparent, it made it possible to develop interventions to target and increase preventive behaviors.

**Motivation.** The HBM was initially developed to gain a better understanding of why individuals were not taking part in one-time preventive health regimens, such as vaccinations (Houchman, 1958). Becker, Drachman, and Kirscht (1974) recreated the HBM to focus on compliance with long-term single health behaviors (see Appendix A). Research revealed the importance of long-term lifestyle behaviors, such as self-examinations and smoking cessation abstinence. Therefore, Table 2.1 identifies research focused on the idea of compliance with new preventive lifestyle behaviors for disease prevention. Rosenstock has always deemed motivation an important concept of behavior change, but never considered it a construct or variable in the HBM (Rosenstock, 1960, 1966). The reformulated HBM classifies motivation as an explanatory variable that directly influences the likelihood of action and indirectly impacts compliance with the health behavior as indicated in Table 2.1 (Becker et al., 1974).

The suggested HBM model (Becker et al., 1974), seen in Figure 1.1, Becker and colleagues investigated the perceptions of the child’s mother to better understand the relationship between motivation and compliance. Within the explanatory variable of motivation there are four variables: physical threat of the disease, control over health matters, attitudes towards medical authority, and general health concerns. A random sample of 125 cases was chosen from a population of children, ages 6-10, with a diagnosed ear infection. The children were all receiving care in a clinic of a teaching hospital and were being treated with liquid oral antibiotics (Becker et al., 1974).
Each subject, and mother or grandmother, participated in a 1 hour long interview after their appointment with the physician (Becker et al., 1974). During the interview, questions related to motivation and compliance with medical regimens were evaluated. The questions related to medical compliance were testing the mother or grandmother’s knowledge of the name of the medication, the number of times it should be administered, follow up dates, if the medication was actually administered, if follow up appointments were kept and what their appointment keeping ratio was. These dependent variables were analyzed to test for a correlation between the four motivation variables. Three out of the four variables indicated significant correlation with compliance to health behaviors ($p<0.05$). Control over health matters lacked statistical significance (Becker et al., 1974).

Becker and Maiman (1975) continued exploring the concept of motivation as a factor in compliance in their review of two decades worth of research. From this review, the construct of motives was composed of concern about health matters in general, willingness to seek and accept medical direction, intention to comply, and positive health activities. These variables, although related to motivation, are different than the previous model (Becker et al., 1974) and have only been suggested, not tested (Becker and Maiman, 1975).

In addition to motivation, Becker and Maiman’s (1975) version of the HBM suggests other variables as factors that influence compliance. As seen in Table 2.1, in 1975, faith in efficacy of care was seen to directly relate to compliance and perceptions that compliant behaviors will reduce threat. If the individual does not believe the behavior will be successful, they will not participate. Interaction between patient and doctor is a modifying factor that directly influences compliance. According to Becker
(1985), knowledge gained by the patient from the doctor can improve the likelihood of action. This educational component, as a modifying variable, is focused on knowledge about the disease and how it can be treated. The better the relationship with the doctor, the more likely the patient will participate in the recommendations issued by the doctor. Due to the work of Becker and colleagues, motivation is included as an explanatory variable of the HBM which is discussed in Table 2.1 (Becker et al., 1974; Becker & Maiman, 1975).

**Self-efficacy.** Like motivation, self-efficacy has also been an important concept of the HBM, but it too, was not originally considered a construct or variable that was incorporated into the model (Rosenstock, 1960, 1966). Self-efficacy has been defined as “the conviction that one can successfully execute the behavior required to produce the outcomes” (Rosenstock et al., 1988, p. 178). The idea of self-efficacy was discussed in Janz and Becker’s (1984) work. As seen in Table 2.1, self-efficacy was discussed as an entity of the *barriers* construct. In 1988, self-efficacy was added to the HBM as an explanatory variable (Rosenstock et al., 1988).

The decision to incorporate self-efficacy in the HBM is a direct reflection of the changing use of the HBM from a single behavior to a constant lifestyle behavior change model. The HBM model has evolved into a framework of how variables interact to predict lifestyle change. When the first HBM was introduced, prevention included behaviors that were short term, such as a vaccination against tuberculosis (Houchman, 1958). Self-efficacy was not considered a variable in the model, because short-term behaviors do not require sustained patient participation or skills. Since then, diseases related to lifestyle habits such as smoking, drinking, and exercising have become of
greater concern. Prevention of conditions related to these behaviors would take more than a one-time visit to a doctor’s office. Full prevention required patients to implement daily preventive behaviors or avoidance of negative behaviors. A patient will only consider making a behavior change when they have a high perceived self-efficacy to do so (Houchman, 1958).

**Expanded health belief model (EHBM).** Burns (1992) proposed a more complex model of the HBM and termed it the expanded health belief model (EHBM) (see Appendix B). Unlike the HBM, which has three stages, five constructs, four variables, and two explanatory variables that describe the likelihood of behavior change, the EHBM has three assessment stages and 10 categories of variables that explain behavior change (1992).

Threat, action, and outcome are the three assessment stages in the EHBM (Burns, 1992). The threat assessment stage evaluates what an individual perceives as their risk of the disease. Threat assessment is threat of illness that is a consequence of perceived susceptibility and perceived severity. Although the constructs of perceived threat, susceptibility and severity have been previously described, they appear all under a single stage in this model. Perceived threat is indirectly influenced by antecedents through stimulator and facilitator variables (see Appendix B). Antecedents, stimulator, and facilitator variables are similar to those modifying variables in the HBM, with the addition of locus of control. Locus of control had been discussed by Rosenstock et al. (1988) in previous research, but it had not been included as a variable in the HBM until the EHBM. Individuals can have an internal or external locus of control. Those individuals who are more internal believe they influence their own health through their
actions. In contrast, those who have an external locus of control believe that their health status is thrust upon them by environmental factors and that they have little or no control (Burns, 1992). Those with a higher internal locus of control are more likely to take preventive behaviors because they believe they can make a difference in their own health.

Threat assessment variables indirectly impact the action assessment stage through two variables, emotional response and normative factor (see Appendix B). These variables have both been discussed in previous literature regarding the HBM (Becker et al., 1974; Janz & Becker, 1984). Emotional response is the fear of the illness that may motivate behavior. Normative factor is what is socially acceptable, regarding what a person should be doing to prevent disease. Emotion and normative ideals influence action assessment, which is composed of beliefs and action evaluation. Efficacy is related to personal beliefs and what an individual thinks can or cannot be done to prevent disease. Action evaluation is similar to the HBM’s likelihood of action stage. If the benefits outweigh the barriers, or costs, likelihood of taking action, or disposition to act, is expected (Burns, 1992).

The final stage is outcome assessment (see Appendix B). Outcome assessment is the action performance, or physical performance of the preventive health behavior, and the assessment of the consequences of taking action. This stage was developed to describe monitoring of the outcome to assess if the desired results were achieved. The physical performance variable can range from short-term behaviors such as a vaccination, to long-term lifestyle behaviors, such as abstinence from smoking. The assessment of consequences is related to the self-regulation of the behavior. A patient maintains a continuous comparison of current health state against desired health state. If results are
positive, the individual is more likely to continue with the preventive behavior (Burns, 1992).

Feedback is the final variable in the EHBM, and it uses the information gained from the outcome assessment stage (Burns, 1992). Feedback can be positive or negative, and rather than it being impacted by all other assessment stages like the outcome assessment stage, it is the variable that influences all stages and other variables of the model (see Appendix B). Positive feedback can be a feeling of accomplishment for participating in the behavior over a given period of time, such as smoking cessation. This would directly impact self-efficacy and improve beliefs, which increases the likelihood of not smoking. If the individual does start smoking again, at any time, it is likely the feedback that he/she will get is negative. His/her self-efficacy will be low, which will decrease his/her likelihood of abstaining from smoking (Burns, 1992).

Opposing views. The HBM has been criticized by Wallston and Wallston (1984) describing the model as a catalog of variables. They believe the model has not been well-articulated to discuss the relationships between the variables, and that the findings are inconsistent. Janz, Champion, and Stretcher (2002) also discuss the ambiguity of the model’s constructs and their relationship to each other. The ambiguity makes it difficult to compare results. Therefore, a consistent measurement tool is essential.

The HBM incorporates several variables and constructs that have been associated with preventive behaviors (Becker et al., 1974; Janz & Becker, 1984). In Becker’s studies (1974; 1984) one or more of the variables was significantly correlated with the desired behavior. When all of the studies are considered, the HBM has provided consistent value as a predictor of preventive action.
Although well tested as a theory, the HBM’s standard of measurement has been discussed as a limitation due to inconsistencies (Becker et al., 1977; Becker & Maiman, 1975; Champion & Skinner, 2008). The questions posed in Becker and colleagues (1977; 1975), and Champion and Skinner’s (2008) studies were dependent on the population and variables included. There have been few studies that establish validity or reliability of the measurements used to assess the outcomes of the HBM (Janz, Champion, & Stretcher, 2002). It is important to create a standard of measurement, such as a validated questionnaire. This instrument should include all constructs of the HBM, have the flexibility to be modified based on the population that is being studied, and be reexamined for reliability and validity with each study. To date, only a few HBM studies have used measurement techniques that have been tested for validity and reliability (Champion, 1984, 1993, 1999; Champion & Huster, 1995).

Internal consistency in measurement tools is essential for a reputable study. Champion (1984) was the first to develop a scale to assess the constructs of the HBM in attempts to establish validity and reliability. Two hypotheses were used to establish internal consistency and test-retest reliability, and two hypotheses were used to test for validity. The first constructs being validated were perceived susceptibility and perceived seriousness of cancer. This construct was compared against the benefits and barriers of conducting breast self-exam behaviors. A convenience sample of 301 women, ages 16 and greater, from a metropolitan area were asked to complete a questionnaire. The questionnaire consisted of Likert scale questions directly related to the construct it was testing (Champion, 1984).
The data were first analyzed using Cronbach’s alpha to indicate internal consistency (Champion, 1984). To accept the construct as reliable, the hypotheses stated that an $\alpha$ score $\geq 0.70$ was required. Perceived susceptibility ($\alpha=0.77$), perceived seriousness ($\alpha=0.78$), and barriers ($\alpha=0.76$) were all accepted. The scale measuring benefits ($\alpha=0.61$) was altered by removing inconsistent items to increase reliability coefficients to $\alpha=0.70$. These scales were then used to examine test-retest correlations. Findings indicated that perceived susceptibility ($\alpha=0.86$), perceived seriousness ($\alpha=0.76$), and barriers ($\alpha=0.83$) were all accepted. Perceived benefits ($\alpha=0.47$) was not supported for the hypothesis, but was still statistically significant ($p\leq0.001$) (Champion, 1984).

The data were also analyzed for validity (Champion, 1984). Construct validity was tested using factor analysis and a $>0.35$ factor loading criterion. Results yielded strong evidence for construct validity by maintaining separate constructs in the HBM, susceptibility, seriousness, benefits, barriers, and health motivation. The constructs were all mutually exclusive where barriers accounted for 35% of the variance, susceptibility (24%), seriousness (28%), benefits (8%), and health motivation (6%) (Champion, 1984).

Construct validity was also tested using multiple regression analysis (Champion, 1984). The HBM constructs were tested using breast self-examination as a behavior. More specifically, scales of barriers and health motivation were tested against the likelihood of behavior change as suggested by the HBM. The test revealed a multiple $R$ of 0.51 and was the constructs were found to be statistically significant when evaluated as predictors of self-report breast self-exam frequencies ($p\leq0.001$). This research shows us
that it is possible to validate and modify scales for reliability to support findings from the HBM (Champion, 1984).

Champion (1993) revised the previously discussed questionnaire in a later study where those constructs were reevaluated and a self-efficacy scale was tested. As seen in Table 2.1, the importance of self-efficacy was demonstrated in response to Rosenstock et al. (1988), officially adding it to the HBM as an explanatory variable. A random sample (n=581) of 35 to 88 year old women participated in a questionnaire sent by mail and took part in an in-home interview. The interview and questionnaire discussed factors related to confidence (12 items), barriers (seven items), susceptibility (five items), health motivation (eight items), seriousness (eight items), and benefits (six items). This was used to test construct validity and test-retest reliability through the administration of the survey/interview over two sessions (Champion, 1993).

Factor analysis was implemented to analyze the data to test for construct validity using a factor loading criterion of >0.45 (Champion, 1993). While all of the factors loaded at 0.45 or greater, four of the individual items did not. These items were related to confidence, barriers, health motivation and seriousness. These four items were removed, and the remaining scales were used in the later testing (Champion, 1993).

After modification, the breast self-exam behavior scale had a Cronbach’s $\alpha=0.83$ and a test-retest reliability score of 0.84 (Champion, 1993). Multiple regression analysis was used to test predictive validity of the constructs related to breast self-exam behaviors. All constructs were significantly correlated to the frequency of behavior; perceived susceptibility ($r=0.51$), perceived seriousness ($r=0.51$), benefits ($r=0.50$), barriers ($r=-0.48$), and self-efficacy ($r=0.50$). Finally, all constructs proved reliable following a test-
retest analysis with coefficients falling in the criteria range of 0.45-0.75; perceived susceptibility ($r=0.70$), perceived seriousness ($r=0.45$), barriers ($r=0.65$), benefits ($r=0.45$), and self-efficacy ($r=0.65$) (Champion, 1993).

**Association with the proposed study.** In the present study, the constructs and variables from the HBM will guide the research. While all of the constructs and variables will be accounted for, the focus of the study will be on the modifying variable, knowledge. More specifically, the study will examine college students’ knowledge regarding T2D and their prior experience with the disease, to see if there is a correlation with the likelihood of preventive action.

Knowledge is an important variable, because it is the basis for the constructs, yet there has been little research with a primary focus on knowledge when implementing the HBM. Furthermore, none of these knowledge-focused studies sampled a college student population (Abbaszadeh, Borhani, & Asadi, 2011; Alidosti et al., 2012; Ghodsbin, Zare, Jahanbin, Ariaifar, & Keshavarzi, 2014; Jones, Weaver, Grimley, Appel, & Ard, 2006; Sharifirad, Entezari, Kamran, & Azadbakht, 2009).

Individual perceptions, perceived susceptibility and perceived seriousness, can be influenced by increasing knowledge (Janz & Becker, 1984). Without knowledge of the risk factors associated with type 2 diabetes (obesity, genetics, and hypertension), it is unlikely that someone would feel they are at great risk or be aware of the severity of the associated complications (heart attack, stroke, blindness, amputation, and premature death). When perceived susceptibility and seriousness are low, the likelihood of taking preventive action is expected to be low (Janz & Becker, 1984).
Perceived benefits and barriers, the other two constructs, are also influenced by knowledge (Janz & Becker, 1984). The ability to calculate if the benefits outweigh barriers can only be accomplished if you have knowledge of what each of these constructs encompasses. For example, a perceived benefit of taking preventive action is that you will decrease risk of stroke, which, in turn, will decrease risk of premature death. A barrier may be the inconvenience of exercising regularly, or time cost. The likelihood of behavior increases only when the value in avoiding premature death is perceived to be higher than the inconvenience of exercising. Knowledge is an essential component when identifying both risks and ways to reduce risk and whether it is worth it to try (Janz & Becker, 1984).

**Knowledge and the Health Belief Model**

As seen in Figure 1.1, knowledge in an essential component of the HBM that predicts behavior modification to limit risk of chronic disease. The HBM focuses on prevention as a means to maintain and regain health status. Therefore, the HBM suggests that the greater knowledge of risk factors related to chronic disease is, the more likely someone is to participate in positive health behaviors in hope of prevention (Janz & Becker, 1984).

In the following sections, knowledge, as a catalyst for change, will be discussed. In the first section, knowledge and its direct impact on preventive behaviors, such as nutrition and physical activity, are reviewed. As you can see in Figure 1.1, knowledge also indirectly impacts behavior through five constructs of the HBM. Therefore, sections to follow will discuss knowledge, its impact on perceived seriousness and susceptibility
literature related to knowledge and the impact of knowledge on perceived barriers and benefits to behavior change.

**Knowledge and preventive behavior.** Knowledge related to preventive behavior and chronic disease has been investigated in young adolescents, older adolescents, middle age adults, and older adults (Jayanti & Burns, 2009; LeClair et al., 2009, 2010; Petosa and Jackson, 1991). In younger populations that have no known risk of T2D, we see a trend between lack of knowledge and poor health behaviors (LeClair et al., 2009, 2010). The following section will present literature related to the practice of preventive behavior among adolescents, young adults, and older adults.

**Adolescents.** LeClair, Marquis, Villalon, and Strychar (2009) studied the social representation of T2D, in adolescents from New Brunswick, Canada. The purpose of the study was to gain insight into adolescents’ views of diabetes in terms of definition, origins, and prevention. The researchers hypothesized that subjects would not be able to describe T2D with much detail. Nineteen focus groups (n=159), with male and female adolescents in grades 5, 8, and 10 were conducted between November and December 2005. The focus groups, led by a dietician, followed an interview guide with three question categories concerning the definition, origins, and prevention strategies of T2D. The audiotaped sessions were transcribed and categorized using qualitative content analysis (LeClair et al., 2009).

Findings indicated a limited knowledge of diabetes. When asked to define T2D, most groups discussed it as a disease (13/19) dealing with sugar (15/19), and more specifically blood sugar (11/19). Fewer groups discussed diabetes in relation to insulin (6/19), a disease that lasts through life (5/19), a problem of the pancreas (3/19), in
relation to blood (7/19). Groups were familiar with behaviors that people with diabetes should do related to eating habits (18/19), injections (17/19), but not as aware of talking pills (5/19) or physical activity (5/19) (LeClair et al., 2009).

Subjects were also asked to discuss factors they associate with T2D. The most common responses were heredity (13/19), age (13/19), physical inactivity (13/19), obesity (12/19), and poor diet (12/19). Less common responses were focused on nutritional habits and included eating too much (7/19), not eating well (6/19), and eating fat/junk food (3/19). When asked about ways to prevent T2D, groups referred to good eating habits (16/19), physical activity (15/19), and control weight (3/19). Only two groups believed that T2D could be prevented, and one female subject said “If you have diabetes, you cannot really stop it…I would say there is no cure” (LeClair et al., 2009, p. 174). From this study, we see that adolescents do not have a complete understanding of diabetes and prevention, which may be a hindrance in preventing T2D in the future (LeClair et al., 2009).

An additional part to the previous study examined adolescents’ familiarity of diabetes (LeClair, 2010). Prior to the focus group, subjects participated in a free association session where they were asked to write any words, word groups, or expressions that came to mind when they heard the term “diabetes.” The purpose of this part of the study was to explore overall awareness of T2D in healthy adolescent subjects. Participants’ responses were collected and classified into principal categories and sub-categories. Frequencies of categories were analyzed using Chi-square tests and precision values were used to create confidence intervals for all categories (LeClair, 2010).
Of the 158 male and female subjects who participated in the focus group, 128 completed the free association activity. Nine principal and 30 sub-categories were identified. The referenced principal categories included sugar (66%), treatment (48%), nature of diabetes (45%), nutrition (41%), blood (38%), complications (18%), physiological manifestations/symptoms (11%), obesity (6%), and physical activity/inactivity (6%). More specifically, sub-categories related to nutrition were diet (13%), sugar-containing foods (12%), other foods (i.e., in Canada’s Food Guide food groups) (11%), eating habits (9%), and general nutrition (7%). These data indicate that about half of healthy adolescents are familiar with some aspects of diabetes, but less than 10% can identify specific factors. This limited awareness, especially in nutrition, physical activity, and obesity may put healthy adolescents at greater risk for development of T2D (LeClair, 2010).

Studies by LeClair et al. (2009, 2010) were focused on T2D, knowledge and prevention, although the questions were not specific. Subjects were asked about diabetes in general, not about type 1 or type 2 diabetes specifically. Therefore, confusion about the type of diabetes could be what led to inaccurate responses to posed questions.

Petosa and Jackson (1991) also investigated adolescents’ knowledge and behavior intention, but rather than looking at T2D, Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS), was the outcome variable. The purpose of the study was to use the HBM concepts to predict students’ intentions to adopt safer sex behaviors. More specifically, the researchers examined AIDS/HIV knowledge and knowledge or preventive actions against AIDS/HIV and the likelihood of taking preventive action (Petosa and Jackson, 1991).
A stratified random sample of twelve schools in the southeastern region of South Carolina were used to recruit students in the seventh, ninth, and eleventh grades (n=769). All subjects were between 12 and 18 years old and agreed to participate in the survey. The survey was constructed using the HBM as its conceptual framework. Subscales measured the individual constructs of perceived seriousness of HIV/AIDS, perceived susceptibility to HIV/AIDS, barriers to action, general knowledge of HIV/AIDS, knowledge of HIV/AIDS transmission, and cues of safer sex intention. This instrument was pilot tested for validity and reliability prior to being administered in a science, biology, or health class by a trained educator (Petosa and Jackson, 1991).

The data were analyzed using Pearson correlations to identify associations between predictor variables and the intention to participate in safer sex. Associations between HIV/AIDS knowledge and predictor variables were also evaluated. Multiple regression analysis was used to further investigate the associations between predictor variables and safer sex intentions (Petosa and Jackson, 1991).

In general, the HBM constructs were strong predictors for safer sex intentions in younger adolescents, but the associations disappeared in older adolescents. All variables were predictors of safer sex intentions in seventh grade subjects. When considering ninth grade subjects, only four of the constructs were significant predictors of safer sex intention, including perceived susceptibility to HIV/AIDS ($R^2 = 0.101$), general knowledge for HIV/AIDS ($R^2 = 0.008$), cues of safer sex intention ($R^2 = 0.033$), and gender. Gender was a significant predictor in all grade levels: seventh grade ($R^2 = 0.017$), ninth grade ($R^2 = 0.106$), and 11th-grade ($R^2 = 0.156$) (Petosa and Jackson, 1991).
After a more in-depth analysis of the predictors associated with safer sex intentions, it was revealed that seventh graders were more likely to have higher safe sex intentions if they had more knowledge related to preventive actions for safer sex \( (r=0.28) \) and more general AIDS knowledge of preventive actions \( (r=0.29) \). Although 42% of the variance in safer sex intention could be explained by the HBM variables, and 32% of the variance in safer sex intent could be explained by knowledge alone, for seventh graders, this association decreased in older subjects (Petosa and Jackson, 1991).

**Adolescents and older adults.** Other studies investigating the impact of knowledge on preventive behavior used both older and younger populations. Moorman and Matulich (1993) investigated the impact of health knowledge and motivation on two health behaviors; health information acquisition behaviors (HIAB), and health maintenance behaviors (HMB). HIAB investigated if health information was obtained from media and labels, professionals in the health field, or casual sources, such as family and friends. HMB focused on health improving behaviors such as: going to a physician for a checkups, improving dietary intake, minimizing stress and alcohol consumption, and eliminating tobacco use (Moorman and Matulich, 1993).

Four hundred and four consumers from Madison and Milwaukee, Wisconsin were chosen through two sampling techniques. Stratification was performed for high and low income consumers, and elderly and young consumers. Then, random sampling was performed through phone interviews. A health behavior survey was administered to all participants to test eight different hypotheses related to health behaviors. It was hypothesized that more health behaviors, HIAB and HMB, would be practiced if the individual had higher health motivation (hypothesis 1), health knowledge (hypothesis 2),
perceived health status (hypothesis 3), locus of control (hypothesis 4), behavioral control (hypothesis 5), educational level (hypothesis 6), income (hypothesis 8), and was younger (hypothesis 7). A multivariate general linear model was constructed to determine the correlations among the variables using the full model, which included both main and interaction effects. A regression equation was also developed to evaluate the effects of motivation on health behaviors (Moorman and Matulich, 1993).

Survey results concluded mixed findings for the impact HIAB and HMB variables on behavior. Hypothesis 2, health knowledge, significantly facilitated five of the eight health behaviors and when motivation was considered, six of the eight were significant. This was the highest influence of all variables. High health knowledge was also significantly correlated with diet (β=0.28) moderation of alcohol use (β=0.45), and elimination of tobacco use (β=0.66). When high health motivation was considered, in combination with high health knowledge, the use of media has a stronger correlation (β=0.24) source of information and casual sources became significant (β=0.22, both) (Moorman and Matulich, 1993).

Overall, the presence of health knowledge does appear to impact health behaviors. Both HIAB and HMB are focused on disease prevention, and high knowledge increases the rate in which these behaviors are performed. This connection may be key to improving disease risk and maintain a high QOL.

Health knowledge is not only important for school age adolescents. The benefit of health knowledge in promotion of healthy behaviors has been demonstrated through the analysis of multiple aspects of human health in older populations, such as those graduating from high school and adult populations. Preventive measures to improve
health, associated with oral and women’s health have been studied in these groups (Fletcher et al., 1989; Jayanti & Burns, 2009; Laiho et al., 1991).

**Young and older adults.** Jayanti and Burns (2009) studied the HBM and models with similar constructs to identify associations with participation in preventive health care behaviors. The purpose of the study was to test a preventive health care behavior model based on insights gained from past research in sociology and marketing. Two hypotheses in this research tested knowledge as a possible stimulus for participation in preventive behavior. More specifically, the hypotheses stated that *individuals with a greater level of health knowledge will exhibit greater levels of general preventive health care behaviors* (H1), and *Individuals with greater health knowledge will exhibit greater levels of response efficacy* (H2). Response-efficacy is belief that a particular behavior will mitigate disease or health threat. Perceived threat of a disease is an intermediate variable that links knowledge and behavior and directly impacts behavior change. It is expected that *individuals with higher levels of response-efficacy will exhibit greater levels of general preventive health care behaviors* (H3) (Jayanti and Burns, 2009).

Subjects were recruited from a primary care facility in a Midwestern city (n=175) and were all patients who visited the doctor regularly and needed referral. The final sample included both male and female subjects (76% females) with an average age of 37.4 years and had some college education (Jayanti and Burns, 2009).

Both dependent and independent variables were measured with multiple items using a self-report Likert scale questionnaire. Seventeen items pertaining to preventive health care scales were borrowed from Moorman and Matulich’s (1993) original scale. Knowledge and response-efficacy were assessed with 2 five-item scales. The data were
analyzed by structural equation analysis using LISREL VII to produce a figure identifying correlations among the variables (Jayanti and Burns, 2009).

All hypotheses were supported with the exception of H1. More health knowledge was associated with greater perceived response efficacy scores ($\beta=0.310$) and greater perceived response-efficacy scores were associated with the practice of more preventive behaviors ($\beta=0.543$). Although knowledge did not directly impact participation in preventive behaviors, it was indirectly associated with response-efficacy. Based on the HBM seen in Figure 1.1, this is the expected association. The relationships among knowledge, response efficacy, and health behavior expressed in the data support the HBM (Jayanti and Burns, 2009).

Laiho, Honkala, and Nyyssonen (1991) examined the oral health behaviors of Finnish 18 year olds ($n=1,010$). The primary aim was to study the association between oral health habits and the following background variables: (a) knowledge of oral health and maintenance of oral health (OH), (b) values of OH, (c) beliefs of sustaining OH, (d) attitudes towards OH education, (e) life situation, (f) socioeconomic factors, and (g) personality. The secondary aim was to study the combination of OH habits on these same background variables. OH habits included health behaviors such as tooth brushing, choosing xylitol, or sugar-free, products, fluoride rinsing, and sweets consumption. Each subject completed a questionnaire that assessed OH habits and the previously discussed background variables, including knowledge (Laiho et al., 1991).

Oral health habits were measured through dichotomous questions. Knowledge of oral health and diseases was evaluated by asking the subject to recall health topics
related to their eight oral health education lessons. Chi-square tests, ANOVA, and multiple regression were used to analyze the data (Laiho et al., 1991).

Subjects who participated in daily teeth brushing had a higher recall knowledge of six of the eight oral health topics. These subjects had a higher percentage of correct responses (%yes/%no); to questions related to: calculus (87/77), gingivitis (87/63), fluoride (86/80), plaque (87/80), sugar (87/76), and check-ups (88/79). Cleanings and appointments were the two topics that did not indicate significance. Based on the regression model, knowledge was a significant explanatory variable for tooth brushing \( R^2 = 0.17 \) (Laiho et al., 1991).

Subjects who chose xylitol products, as opposed to those containing sugar, were also significantly correlated with six of the eight oral health topics; calculus (53/44), fluoride (53/40), plaque (54/42), sugar (53/42), check-ups (53/44), and appointments (55/47) (Laiho et al., 1991). Cleanings and gingivitis were not significant topics when xylitol gum was considered. Fluoride rinsing was associated with both a high (75%) and low (60%) knowledge of dental plaque (Laiho et al., 1991).

When all health habits were considered, knowledge was significantly correlated with six of the eight oral health topics; calculus (2.3/2.5), gingivitis (2.1/2.5), fluoride (2.2/2.5), plaque (2.2/2.5), sugar (2.2/2.5), and check-ups (2.3/2.5). Health knowledge regarding OH and diseases has a great impact on OH behaviors such as brushing teeth daily and choosing xylitol products. This relationship has shown that subjects prioritize oral health to prevent oral diseases when they are informed about the subject (Laiho et al., 1991).
Similar results regarding knowledge and behavior were found when investigating cancer prevention behaviors in women’s health (Fletcher et al., 1989). Three hundred women, ages 40 to 68 years of age, from a clinic in North Carolina, were interviewed to examine their knowledge, attitudes, beliefs, and behaviors of breast self-examination (BSE). This age demographic was chosen because this population is at the greatest risk for breast cancer. Subjects were excluded if they were previously diagnosed with breast cancer, expressed concerns regarding breast cancer, or had any mental or physical disabilities. One of the hypotheses that was tested investigated the relationship between health knowledge and sensitivity (% of lumps detected), specificity (% of models examined without a false positive), and frequency (number of time BSE performed in past 6 months) of BSE (Fletcher et al., 1989).

Subjects participated in a one hour, in-home, interview. During the first part of the interview, subjects were asked to examine six manufactured silicone breast models to practice testing for cancerous lumps. Their abilities to correctly perform a breast assessment and detect growths were monitored to assess their level of BSE sensitivity and specificity in this area of women’s health. A 40 minutes structured interview followed the examinations to assess the subjects’ knowledge, attitudes, and beliefs regarding breast cancer, and frequency of BSE. More specifically, level of knowledge, and risk factors of vulnerability for cancer, were discussed (Fletcher et al., 1989).

A split-half research design was performed to analyze the data because there were expected to be relationships between many variables. In the first set, nonparametric Wilcoxon rank-correlation tests were performed to identify univariate relationships between variables. The second subsample set was then used to validate the first.
Associations were detected between sensitivity and specificity of BSE, although significance was not recorded. Those that were more informed about health detected more lumps and had less error than those that were less knowledgeable ($r=0.21$). Frequency in which BSE were performed was also associated with knowledge of BSE ($r=0.38$), knowledge of correct performance of BSE ($r=0.31$), and use of correct BSE methods ($r=0.36$). These relationships identify knowledge as an important component in early detection of breast cancer. Those who were not as knowledgeable were less likely to participate in detection behaviors and put themselves at greater risk for disease (Fletcher et al., 1989).

Physical activity and nutrition behaviors are not the only health behaviors that can improve when knowledge is present. From these studies, examining oral and women’s health, it may be evident that knowledge is an important factor in increasing the use of preventive health measures.

In addition to overall preventive behaviors, more specific health behaviors have also been studied. Health behaviors such as physical activity and good nutrition may be crucial components in combating most chronic diseases. Many studies have investigated the relationship between health knowledge and behavior related to participation in physical activity (Avis, McKinlay, & Smith, 1990; Hivert, Langlois, Berard, Cuerrier, & Carpentier, 2007; Howze, Smith, & DiGilio, 1989; Tamirat, Abebe, & Kirose, 2014; Sallis et al., 1999) and food consumption (Abood, Black, & Birnbaum, 2004; Boeckner et al., 1990; Franko et al., 2008; Ha & Caine-Bish 2009; Ha, Caine-Bish, Holloman, & Lowry-Gordon, 2009; Ha & Caine-Bish 2011; Kolodinsky, Harvey-Berino, Berlin, Johnson, & Reynolds, 2007; Krešić, Jovanović, Žeželj, Cvjanović, & Ivezić, 2009;
Knowledge and physical activity behaviors. In addition to preventive practices, moderate to high levels of regular physical activity are essential in preventing chronic disease (Knowler et al., 2002). A discussion of literature related to subjects’ current knowledge and interventions to improve knowledge is presented.

Current knowledge. Avis, McKinlay, and Smith (1990) investigated knowledge related to cardiovascular disease and its impact on health behavior. Four specific research questions were addressed: (a) How informed is the general population about reducing risk for cardiovascular disease?; (b) How do sociodemographic factors, self-perception of health, and actual risk factors relate to knowledge?; (c) What is the relationship between knowledge and health behavior?; and (d) What are possible reasons for inconsistencies between awareness and behavior (Avis et al., 1990)? Seven hundred and thirty-two healthy male and female subjects, between the ages of 25-65 years, were randomly selected from the greater Boston area. Subjects were excluded if they had coronary heart disease, diabetes, or hypertension (Avis et al., 1990).

Following the telephone screening, subjects participated in a baseline interview that was conducted to assess stress, family history, smoking habits, and self-report physical activity. The Harvard Alumni scale was used to quantify physical activity in kilocalories, and a cardiovascular disease (CVD) risk factor awareness assessment was used to determine level of knowledge related to CVD. Measurements related to risk factors and health behaviors were also performed, including height, weight, blood
pressure, and cholesterol. Multiple regression analysis, logistic regression analysis, and frequencies were used to quantify the data (Avis et al., 1990).

Overall, subjects were most knowledgeable regarding the following cardiovascular disease risks: physical activity, cutting fat, smoking, stress, weight, sodium intake, and blood pressure. More specifically, results indicated that there were significant positive correlations between knowledge and level of education ($r=0.26$), being female ($r=0.11$), and participation in physical activity ($r=0.08$). There were also trends that suggested that higher the subject’s risk was for cardiovascular disease, the more likely they were to be aware of the risks, but not necessarily participate in the behaviors to prevent the disease. This could be due to many unexplained reasons, such as not having the knowledge to seek help in these areas to reduce risk (Avis et al., 1990).

Tamirat, Abebe, and Kirose (2014) also investigated the relationship between existing knowledge and the likelihood of participation in physical activity. Rather than healthy subjects, researchers looked into a population with T2D. The aim of this study was to investigate the predictors of physical activity among type 2 diabetic patients based on the HBM. Three hundred and nineteen subjects (225 males; 94 females) with a mean age of 55.3 years were randomly recruited for this study. Inclusion criteria for participation included diagnosis of T2D for a minimum of 6 months and participation in a follow-up program at Jimma Specialized Hospital diabetic clinic in southwest Ethiopia. This hospital offered referrals and education to their patients (Tamirat et al., 2014).

Subjects were asked to complete a questionnaire that addressed the various aspects of the HBM: knowledge of T2D and physical activity, cues to action, perceived barriers, perceived benefits, perceived self-efficacy, perceived susceptibility, perceived
severity, and participation in recommended physical activity. The likelihood to participate in physical activity was measured using seven items. Based on responses, subjects were considered either high physical activity (if they participated in physical activity a minimum of three times a week for 30 continuous minutes) or low physical activity (anything less than those criteria). Knowledge related to T2D and physical activity was also measured using the questionnaire. Subjects were classified as both good or poor knowledge about T2D, and good or poor knowledge about physical activity. Good knowledge for both was a score greater than or equal to the mean score, while poor knowledge was any score less than the mean (Tamirat et al., 2014).

The data were analyzed using both backward stepwise logistic regression analysis and multiple logistic regression analysis with a significance level of $p<0.05$. Overall, subjects had a high knowledge of T2D. Two hundred and seventy-five subjects (87.5%) were considered to have good general knowledge of T2D, 316 (99.1%) were knowledgeable about the signs and symptoms of T2D, and 296 (92.8%) knew that it was possible to manage diabetes (Tamirat et al., 2014).

Knowledge related to physical activity varied. Three hundred and twelve (97.8%) subjects replied that it is possible to control T2D with physical activity, although 218 (68.3%) said they had no knowledge about physical activity. Two hundred and eighty-one subjects (88.1%) also reported that they perform below the recommended level of physical activity. This could be because they do not know how to perform the behavior. In the final analysis, a significant correlation between knowledge of physical activity and the likelihood of participating in recommended physical activity was revealed \[\text{COR}=0.17, 95\% \text{ CI (0.08, 0.33); COR}=0.2, 95\% \text{ CI (0.05, 0.64)}\] (Tamirat et al., 2014).
Existing knowledge of physical activity and disease does seem to play a role in the practice of physical activity. Knowledge can also be altered through an intervention and formal education. The following two sections will discuss studies that address knowledge in each of these contexts.

**Intervention to improve knowledge.** To directly evaluate the impact of knowledge on physical activity behavior, interventions to improve knowledge related to physical activity have been used. Hivert, Langlois, Berard, Cuerrier, and Carpentier (2007) studied the effects of an educational/behavioral intervention on preventing weight gain in college students. The intervention consisted of educational seminars designed by a dietician and taught by endocrinologists and a physical education specialist. Each seminar was about 45 minutes in length and discussed information related to increasing knowledge regarding weight gain, the Canadian dietary recommendations, exercise, expected benefits of physical activity, maintenance of health, behavior modifications, goal setting, and monitoring strategies. Hivert et al. (2007) hypothesized that a small group, seminar-based education and behavioral program aimed at improving lifestyle would prevent the usual weight gain observed in young university students.

One hundred and fifteen non-obese (body mass index (BMI) between 18 and 20) freshmen in a Faculty of Medicine were recruited for this study (Hivert et al., 2007). Subjects were excluded if they had a medical condition or were regularly taking medication other than oral contraceptives. Intervention and control groups were determined through gender and BMI stratification, and subjects were randomly assigned to a control or intervention group (Hivert et al., 2007).
Subjects in the intervention group attended seminars every two weeks for the first two months of the semester and once a month thereafter for 24 months. Anthropometric measures were performed at baseline and 3, 6, 12, 18, and 24 months, following a 12 hour fast. Anthropometric measures included weight, height, waist circumference, lean body mass, blood pressure, and pulse rate. Total plasma cholesterol, triglycerides, and high-density lipoprotein cholesterol were only measured at baseline and the 24 month follow-up. At baseline, 12 month and 24 month follow-up, leisure physical activity was assessed with the Canadian Fitness Survey questionnaire, and fitness capacity was measured with a VO$_2$ sub-maximum test. Total calorie and macronutrient intakes were evaluated using a 3 day food diary every year (Hivert et al., 2007).

The data were analyzed using mixed model repeated measure ANOVA with time, group and the interaction of both as independent variables to compare the change in anthropometric data, physical activity level, fitness level, dietary intake, lipid profile, and blood pressure between groups over 24 months. Nineteen subjects either dropped out from the study or were dismissed due to medical conditions. A significance level of $p<0.05$ was used for all analyses (Hivert et al., 2007).

Significant and non-significant but trending differences were seen in weight ($p<0.04$), physical activity ($p<0.15$), nutrient consumption ($p<0.68$), and cholesterol ($p<0.06$) between the intervention and control groups at follow-up. On average, body weights of subjects in the control group increased (+0.7±0.6), while subjects in the intervention group decreased (-0.6±0.5) at 24 months. As expected, BMIs were also significantly different in the same proportions at 24 months for the control (+0.2±0.2) and intervention groups (-0.3±0.2). When subjects who did not complete the intervention
were accounted for, fat mass increased in the control group (+0.4±0.2), and decreased in the intervention group (-0.3±0.2) at 24 months (Hivert et al., 2007).

At final measure, physical activity was still considered high in the intervention group (3.33 k/cal/kg/day at baseline; 3.18 k/cal/kg/day at final) but decrease from baseline in the control group from high to moderate (3.78 k/cal/kg/day at baseline; 2.88 k/cal/kg/day at final) at 12 months. Long term and short term changes in physical activity were not significant (Hivert et al., 2007).

In reference to mean nutrient intake, changes in total caloric and macronutrient intake were not significant, although alcohol consumption did significantly increase in the control group (+0.3±0.3) and decrease in the intervention (-0.9±0.4) group. Differences were also observed in triglyceride levels, which increased in the control group (+0.10±0.6) and decreased in the intervention group (-0.10±0.8). This could be due to the differences in levels of physical activity between the groups (Hivert et al., 2007).

Although we see many positive long term effects of the intervention program, the concept of knowledge is never directly measured. The researcher made an assumption that the intervention is improving the subjects’ knowledge, and the previously mentioned changes are a result (Hivert et al., 2007).

Howze, Smith, & DiGilio (1989) investigated an intervention’s effect on the factors that affect the adoption and compliance of regular exercise in older adults. The intervention included knowledge regarding physical activity and its importance. The researchers also sought to describe changes in fitness levels that may be indicators of disease. One hundred and two sedentary, older adults, were recruited via the radio and
area newsletters to participate in a 10 week exercise program. Healthy male and female
sedentary subjects (n=102), between 55 and 84 years of age from west Washington, DC
volunteered to complete the exercise program. Subjects were not eligible for the study if
they were not ambulatory, were seriously visually impaired, or had any medical
conditions that would affect their participation in the program (Howze et al., 1989).

A pretest and posttest questionnaire was administered to all subjects to assess
exercise knowledge, exercise beliefs, and attitudes concerning the exercise program.
Pretest fitness measurements such as, height, weight, blood pressure, heart rate,
flexibility, and aerobic capacity were conducted for each subject by a health professional.
Flexibility was assessed using the sit and reach test and aerobic capacity was evaluated
based on distance covered during a 12 minute walk. Subjects also participated in the
program sessions 2 hours, twice a week, for 10 weeks. The 2 hour session included a 30
minute warm up, a 15 minute break, a 30 minute educational component or walk, and a
45 minute mild or moderate physical activity session. Following the program, posttest
fitness measurements were conducted, and subjects were asked to self-report their
exercise behavior and any benefits or problems they encountered (Howze et al., 1989).

Adherence to the program was 51% by week 10. Of those compliant, 61% were
high attenders, attending 15 or more sessions, and 32% were low attenders. Of the low
attenders, 32% attended 8-14 sessions and 7% attended less than eight sessions. Overall,
fitness levels increased for all subjects. Significant changes were evident in mean
systolic blood pressure and mean flexibility for both the high attenders (141 mmHg to
127 mmHg; 23cm to 31cm) and low attenders (135 mmHg to 129 mmHg; 21 cm to 28
cm). Significant changes in diastolic blood pressure (81 mmHg to 78 mmHg), weight (162
lbs to 161 lbs), and endurance (8 laps to 9 laps) were only seen in the high attenders (Howze et al., 1989).

Findings from a regression analysis of pretest and posttest program variables on behavior showed that exercise behavior was significantly correlated, or trending towards significance, with commitment to exercise ($R^2=0.3941; p<0.05$), perceived benefits of exercise ($R^2=0.2285; p<0.10$), and exercise knowledge measured by frequency and duration. Exercise knowledge was regarded as number of days/week necessary for exercise to help ($R^2=0.3337; p<0.05$) and number of minutes/time for exercise to help ($R^2=0.1995; p<0.10$). These variables accounted for 34% of the variance in exercise behavior. Ultimately, those individuals who had greater health knowledge were more likely to adhere to exercise routines, which may improve level of physical activity and decrease chance of chronic disease (Howze et al., 1989).

**College course to improve knowledge.** Similar to the implementation of an intervention, Sallis et al., (1999) evaluated the effects of a college course to improve physical activity knowledge. College students with a senior level status were recruited from an urban university in southern California. Three hundred and thirty-eight subjects, between the ages of 18 and 29 years, participated in the study (153 males; 185 females) (Sallis et al., 1999).

All subjects were administered The Physical Activity Readiness Questionnaire to screen for physical limitations. Subjects were then randomly assigned to the control and intervention groups. The control group participated in a knowledge-oriented course about various health issues, while the experimental group participated in the GRAD intervention (Sallis et al., 1999).
The GRAD intervention was a two credit, one semester, college course comprised of pre-graduation and post-graduation components. This study focused on aspects of pre-graduation which consisted of a lecture and laboratory component. Content was introduced during the lecture and the laboratory promoted the practical application of the content. The lecture was taught by a professor once a week for 50 minutes. The first 25 minutes of the course focused on exercise science while the second half of the class was geared towards behavioral science. The content included: (a) health benefits and risks of physical activity, (b) recommended physical activity patterns to promote health and fitness, (c) principles of injury prevention, and (d) principles and methods of behavioral self-management. Subjects’ knowledge was assessed with two examinations (Sallis et al., 1999).

The laboratory experience was 110 minutes per week and was taught by a trained peer. The purpose of this laboratory was to teach physical activities and help students use self-management techniques to implement a personal physical activity program. During the first 15 minutes, subjects participated in physical activity. Then subjects participated in a twenty five minute behavior change discussion group, and 45 minutes of physical activity followed. Subjects could choose from step aerobics, walking, jogging, resistance training, and stretching for the physical activity component. Subjects’ knowledge was assessed by the quality of a written physical activity plan (Sallis et al., 1999).

Subjects participated in measurements at baseline, posttest, one year, and two years after baseline. This study investigated the short term adoption of physical activity. During these sessions, subjects participated in a seven day Physical Activity Recall interview and completed a 20 page questionnaire. The Physical Activity Recall interview
assessed five variables; total physical activity, hours per week in leisure moderate-intensity physical activity, hours per week in leisure vigorous-intensity physical activity, minutes per week in flexibility exercises, and minutes per week in strength exercises. The questionnaire assessed physical activity and exercise patterns, determinants of physical activity, and fitness levels. Subjects were defined as either “active” or “inactive” for data analyses (Sallis et al., 1999).

The data were analyzed using a three way repeated measures analysis of covariance (ANCOVA). The three interactions that were assessed were: intervention and time; activity status and time; and intervention, activity status, and time. Significance was set at $p<0.05$ (Sallis et al., 1999).

No significant interactions were detected for male subjects, although there were many for female subjects. The three way interaction indicated that the intervention was effective in increasing total leisure time physical activity for active female subjects (F=3.76) while those active females in the control group experienced no change (F=0.85). Independent of activity status, both active and inactive female subjects were impacted by the intervention, and significant increases in strengthening exercises (F=26.03) and flexibility were apparent (F=11.31) (Sallis et al., 1999).

Knowledge related to risk factors of chronic disease is important in practicing preventive behaviors, especially physical activity. For the most part, when information is made available, changes in physical activity behavior are evident, but what about food intake? The following section will address the impact of knowledge on nutrition behavior.
Knowledge and nutrition behavior. Although physical activity is crucial in chronic disease prevention, it is only part of the equation. Nutritional choices, such as portion consumption, eating patterns, and food selection are also important factors to consider (Hu et al., 2001). Nutrition behaviors impacted by current knowledge and acquired knowledge have been studied (Franko et al., 2008, Matveinko, Lewis, & Schafer, 2001). What has not been investigated is knowledge of chronic disease in relation to nutritional knowledge and behaviors in the college population (Boeckner et al., 1990). Research has also been conducted on older populations in relation to nutrition knowledge and chronic disease.

Current knowledge. Kolodinsky, Harvey-Berino, Berlin, Johnson, and Reynolds (2007) investigated the overall eating patterns of college students in comparison to their nutritional knowledge. The primary aim of their study was to evaluate self-report eating patterns of college students to identify how closely they followed the Dietary Guidelines for Americans. A secondary aim was to examine if their eating patterns were related to their knowledge or the recommended dietary guidelines (Kolodinsky et al., 2007).

First year college students in two colleges at a single northeastern university were recruited to participate in this study (n=200). One hundred and thirty-six females and 64 males, between the ages of 18 and 20 years, with an on-campus meal plan, participated in baseline measurements. They were weighed and measured for height to calculate BMI, and completed a self-report survey. The survey was internet based and investigated the relationship between nutritional knowledge and eating behaviors (Kolodinsky et al., 2007).
Behavior questions on the survey were in reference to The My Pyramid Food Guidance System. Subjects were asked to report if they were sedentary, moderately active, or active. Their activity level and BMI score were used to determine their specific dietary recommendations. Subjects were also asked to report their nutrition intake for fruits, vegetables, dairy, proteins, grains, whole grains, and various colored vegetables. The United States Department of Agriculture Diet and Health Knowledge Survey guidelines were used to assess food decisions, another measurement of nutritional intake. Subjects were asked if, given the choice, they would choose a healthier option over an unhealthy option, such as low-fat cheese instead of normal-fat cheese (Kolodinsky et al., 2007).

Nutritional knowledge questions were also based on the United States Department of Agriculture Diet and Health Knowledge Survey. These questions were more specifically related to the Dietary Guidelines for Americans 2005 and pertained to energy, fat, sugar, fiber, importance of fruit and vegetable intake, and importance in maintaining a healthy weight. Each subject was given a knowledge score in the range of 1-36 (Kolodinsky et al., 2007).

ANOVA was used to compare knowledge scores with perceived amount of food from each category and t tests were conducted to determine if knowledge scores were significantly associated with subjects choosing more healthy food alternatives (Kolodinsky et al., 2007).

Overall, significant differences were seen between knowledge of dietary guidelines and self-report food consumption for fruits, dairy, proteins, and whole grains. Subjects who consumed greater than the amount of recommended fruits scored
significantly higher on the nutritional knowledge scale than those who ate less than the recommended amount of fruits (F=3.72). Subjects who consumed the recommended amount of dairy had greater nutritional knowledge than those who ate more than recommended (F=6.97). Also, those who consumed more than the recommended amount of dairy scored poorest on the nutritional knowledge scale. Those subjects who consumed less than the recommended amount of protein had the greatest nutritional knowledge score and those that consumed more than the recommended amount of protein had the least nutritional knowledge (F=9.30). In relation to whole grains, subjects who consumed the recommended amount of whole grains had a greater nutritional knowledge than those who consumed less than the recommended amount of whole grains (F=3.16) (Kolodinsky et al., 2007).

When considering food alternatives, more healthy food decisions were made by subjects who were more knowledgeable. Subjects with more nutritional knowledge were more likely to eat lower fat luncheon meats as opposed to regular luncheon meats (T=4.65), drink skim or 1% milk instead of 2% milk (T=4.62), eat low-fat cheese when eating cheese (T=2.08), eat ice milk, frozen yogurt, or sherbet instead of ice-cream (T=3.59), and used low-energy or no salad dressing instead of regular salad dressing (T=5.81) (Kolodinsky et al., 2007).

The My Pyramid Food Guidance System (MPFGS) was used in another study investigating college students’ nutrition behavior (Krešić, Jovanović, Žeželj, Cvjanović, & Ivezić, 2009). The aim of this study was to examine the relationship between nutritional knowledge and dietary intake among university students. The researchers
hypothesized that better nutritional knowledge may be associated with a daily diet more in adherence with recommendations of the MPFGS (Krešić et al., 2009).

One thousand and five Croatian university students, with a mean age of 21.7 years, were randomly recruited to participate in the study (264 males; 741 females). All subjects were asked to participate in a three part instrument that considered demographic data, general nutritional knowledge, and food intake. In reference to demographic data, gender, year of study, and living arrangements were recorded. Subjects were also asked to rank their physical activity so researchers could calculate their recommended food intake (Krešić et al., 2009).

General knowledge was assessed with questions related to expert recommendations regarding increasing and decreasing intake of different food groups, nutrient knowledge, food choice, and the relationship between diet and disease. Each subject was given a knowledge score out of 96. Food intake was estimated using the Quantified Food Frequency Questionnaire. The questionnaire was composed of 97 different items that were all arranged by food group. Subjects were asked to report their usual frequency of consumption for the specific food groups over the past twelve months. These data were converted to a number value for each group according to the MPFGS using Croatian tables of chemical composition of food and drink. The food groups considered were grains, fruits, vegetables, milk and dairy products, meat and beans, and oils. Other groups that were also considered were total daily energy intake, and extras which included energy that was obtained through the consumption of solid fats, added sugars, and alcohol (Krešić et al., 2009).
One-way ANOVA, followed by a post-hoc Scheffé test, was used to compare knowledge and adherence to recommendations for gender and university status subgroups. Nutritional knowledge quartiles were also constructed and ANOVA tests were used to compare differences in food intake among the quartiles (Krešić et al., 2009).

Generally, females (69.86±6.32) and senior level students (65.33±6.33) had significantly higher nutritional knowledge scores in comparison to their male (62.09±7.83), freshmen (59.81±5.83) and junior (62.41±6.77) level student counterparts. Subjects who adhered to the recommended overall dietary intakes expressed significantly higher levels of nutrition knowledge (66.62±6.66) than those who did not follow the recommendations (62.67±6.79). More specifically, adherence to the recommended daily number of servings of food groups increased as level of knowledge increased. Those food groups that were significant in their association were daily intakes of grains (75.65±33.58), meat and beans (44.70±37.41), vegetables (48.53±23.96), fruit (74.34±42.34), and oil (42.44±33.54). Negative trends were also expressed in the consumption of extras (49.52±68.03) and total energy intake (109.23±33.11). Subjects with a higher nutritional knowledge were more likely to restrict themselves in these areas (Krešić et al., 2009).

**Intervention to improve knowledge.** Another study related to nutrition knowledge investigated the impact of an internet based interactive health program, MyStudentBody.com-Nutrition (MSB-N) on health behaviors (Franko et al., 2008). MSB-N was designed to educate college students on nutrition and physical activity. The program consists of: (a) a rate myself assessment; (b) topics related to nutrition 101, eating on the run, weighing in, and fitness; (c) resources; and (d) three informal links.
These informal links were “ask the expert,” “student voices” and, “college news.” The purpose of this study was to test the effectiveness of MSB-N on college student health behavior (Franko et al., 2008).

A random sample of full-time undergraduate students, 18-24 years of age was selected for this study (n=476). Subjects were excluded if they were currently on a dietary program. Subjects were randomized into experimental 1 group (exp1) (n=165), experimental 2 group (exp2) (n=164), and a control group (n=147). In exp1, subjects participated in two web sessions. In exp2 subjects participated in two web sessions and a booster session where they had extra time to explore health information that was of interest to them. Subjects in the control group participated in two sessions of an online interactive anatomy program. All internet sessions were approximately 45 minutes in length (Franko et al., 2008).

The primary hypothesis was that exposure to MSB-N would improve nutrition behavior relative to those who did not participate. A secondary hypothesis was that participants in the experimental group would demonstrate: (a) improvements in motivation to change health behaviors, (b) improve nutritional knowledge, (c) increase physical activity, (d) improve social support and attitudes related to healthy eating, and (e) improve attitudes towards exercise (Franko et al., 2008).

Throughout the study, subjects were assessed at baseline, posttest, 3 months, and 6 months posttest. At posttest, exp1 and exp2 previously completed the first session. At 3 months posttest exp1 completed the second session and exp2 completed the second and third sessions. The assessments took about 45 minutes to complete and consisted of six questionnaires: (a) Food Frequency Questionnaire; (b) Stages of Dietary and Physical
Activity Change; (c) Nutrition Knowledge Test; (d) International Physical Activity Questionnaire; (e) Social Support, Encouragement and Self-Efficacy for Dietary Changes; and (f) Exercise Benefits/Barriers (Franko et al., 2008).

By month 6, 422 subjects completed all assessments. Mixed models were used to estimate the differences among all three groups and time points. Gender, baseline BMI, and school pretest measurement of variable were all controlled. One-sided significance tests were also used and analyzed at an $\alpha=0.05$ level (Franko et al., 2008).

For the primary hypothesis, results indicated a significant increase in mean single-item fruit and vegetable intake for both exp1 (+0.45) and exp2 (+0.46) compared to the control at posttest (+0.17). This change in fruit and vegetable intake was not significant at 3 or 6 months. There was also no significant change in fat intake that these time points (Franko et al., 2008).

The secondary hypothesis indicated significant effects from the sessions on four of the five behaviors. Subjects in exp1 and exp2 were more motivated to change their fruit and vegetable intake (35.5% and 35.5%) and change dietary fat intake (27.7% and 32.7%) at posttest than those who were not exposed to the program (16.4% and 17.9%). In relation to mean nutritional knowledge, those in exp1 (+2.12) and exp2 (+2.54) had a greater increase in knowledge than those in the control group (+1.40) at posttest. Similar trends were also indicated at 3 and 6 months, but were not as strong. Subjects in exp1 also had a greater mean score for encouragement for dietary change (+0.07), and self-efficacy to eat fruit and vegetables (+0.36) at posttest than the control group (-0.26 and -0.14). Exp2 had increased mean score for social support for dietary change at 6 months (+0.19) in relation to those who didn’t experience the intervention (-0.92). Finally, at 3
months exp1 (-2.70), and at 6 months exp2 (-2.77) reported experiencing significantly less barriers than those in the control group (-0.70, -1.33). The mean experience of benefits increased for both exp1 (+3.66) and exp2 (+2.39) at 3 months, and exp1 (+7.98) at 6 months, while the controls experienced fewer benefits at 3 months (-0.50) and little change at 6 months (+5.48) (Franko et al., 2008).

Abood, Black, and Birnbaum (2004) also implemented an intervention to evaluate the impact of nutrition knowledge on dietary behavior. Thirty Division I female university athletes (n=15 swim team; n=15 soccer team) were recruited for the study. The mean age of the subjects was 19.5 years. The research design was a pretest-posttest control group design. During the pretest and posttest, subjects were asked to complete a 3 day diet record and nutrition knowledge questionnaire. Students were taught how to complete the record before they submitted the official documentation. These data were analyzed with the Nutritionists IV software program (Abood et al., 2004).

The knowledge questionnaire consisted of 42 items. These items were related to the intervention topics: (a) caloric intake and expenditure; (b) carbohydrates; (c) fat and protein; (d) fluids, calcium, iron, and zinc; (e) diet record analysis; (f) application of nutrition principles; (g) eating on the road; and (h) eating problems and solutions. Subjects were given a pretest and posttest score for nutrition knowledge (Abood et al., 2004).

The nutrition knowledge and dietary practice intervention consisted of eight, weekly, 1 hour sessions. The activities were based on the previously discussed topics and the subject athletes were encouraged to apply the information in ways that would benefit
them. The control group attended a studyhall during the same times as the intervention session in another building on campus (Abood et al., 2004).

The between groups differences were analyzed using the Mann-University U test and the Fisher exact probability test measured the difference in number of changes between groups in positive dietary changes. Significance was set at $p<0.05$ (Abood et al., 2004).

Overall, a significant number of positive dietary changes that favored the experimental group were present. More specifically, mean nutrition knowledge increased significantly in the experimental group (29.5±0.54 to 32±0.68) and slightly decreased in the control group (28±0.32 to 27.5±0.61) from pre- to posttest. All of the subjects were already meeting the athlete recommended intake of macronutrients, so little change was seen in relation to protein, and fat intake. However, there was a significant decrease in the control group’s carbohydrate intake (62±7 to 57±9) (Abood et al., 2004).

In reference to calcium, there were no significant changes, but mean levels did increase in the experimental group (659±229 to 809±344), and decreased in the control group (918±305 to 695±329), from pre- to post-intervention. A similar trend was also seen in iron and fiber intake. The decrease in fiber intake for the control group was significant (16±11 to 10±7) (Abood et al., 2004).

Boeckner, Kohn, and Rockwell (1990) studied the effects of a six session nutrition education program, “Eating for a Healthier Tomorrow,” on food consumption behaviors of an older population. The program focused on modifying food selections though the teaching of risk factors for coronary heart disease, cancer, osteoporosis, and obesity. A registered dietician and Cooperative Extension Service agent administered a
food frequency pre-test, six educational sessions, and a food frequency posttest to 142 subjects. Subjects were generally 40-59 years of age (52%), mostly women (90%), educated beyond high school (60%), in varying occupations (homemaker, 38%; professional/clerical, 34%; and retired, 15%), obese (31%), and high blood pressure (27%) (Boeckner et al., 1990).

Following an interview related to demographic information and family health history, subjects were asked to answer a pre- and posttest food frequency questionnaire to identify changes in food consumption behavior. Intakes of products were assessed for each subject using food frequency questionnaires for the following food groups: dairy, protein, fruit and vegetable, bread and cereal, fat, and miscellaneous (tea/coffee, desserts, and sodium rich foods). ANOVA was used to detect differences between pre and post food frequencies and recorded the least squares mean (Boeckner et al., 1990).

Results indicated significant changes in food consumption associated with completion of the education sessions ($p<0.05$). More specifically, subjects modified their mean dairy consumption by selecting more lower-fat dairy products (0.37±0.50 to 0.51±0.50) and less high-fat cheese (0.34±0.03 to 0.20±0.02). When considering protein, subjects decreased their mean total protein intake (1.94±0.10 to 1.68±0.10) and ate less red meat (0.26±0.03 to 0.16±0.03) following the intervention. Mean total breads and cereals consumed (3.55±0.16 to 3.12±0.15), and amount of enriched white grains decreased (1.45±0.10 to 1.03±0.10). There was little change in total fats, but a significant decrease was identified in mean consumption of foods that were rich in saturated fat (0.93±0.08 to 0.60±0.08). Significant reductions in mean tea and coffee (2.16±0.20 to 1.66±0.19), desserts (1.45±0.11 to 1.01±0.11), and sodium products (2.12±0.11 to
1.58±0.11) were also expressed. The only change in food consumption that was not significant was the subjects’ mean intakes of fruits and vegetables, which remained high (5.11±0.29 to 4.99±0.29) (Boeckner et al., 1990).

Another form of intervention that has been used to improve college students’ knowledge related to nutrition is the use of contact with peer educators. White, Park, Israel, and Cordero (2009) investigated the longitudinal effects of peer health education on health behaviors of undergraduate college students. More specifically, these health behaviors were limited to eating behaviors, nutrition, and drug and alcohol consumption (White et al., 2009).

Peer Health Educators (PHE) are trained students who have one health focus area and disseminate their services to other students campus-wide. For the purpose of this study, PHE were either trained for Healthy Eating and Lifestyles (HEALs), which focused on nutrition and eating behaviors, or Students Teaching Alcohol and Drug Responsibilities (STARs), which focused on consumption and behaviors related to alcohol and other drugs (AOD). Trainings for the PHE consisted of a series of courses and field placements in health related professions. Of the 418 PHE who went through training, 326 were chosen to be PHE for this study (White et al., 2009).

The PHEs’ roles are to make contacts with other students related to their training, STARs or HEALs. Throughout the course of the study, PHE made 44,710 contacts. These contacts included presentations, awareness activities, such as National Alcohol Screening Day, and individual informal contacts to provide health referrals, emotional support, and direct assistance (White et al., 2009).
Subjects recruited for the study were non-PHEs, undergraduate college students (n=146; 53 males, 91 females). The study took place from fall 2003 to spring 2006, and, at the start of the study, the mean age of subjects was 18.24 years. Subjects were asked to complete a survey every year for the three year study. The survey measured knowledge, attitudes, and behaviors related to health behaviors and AOD use, as well as the frequency and type of contact they had with the PHE (White et al., 2009).

The data were analyzed using ANCOVAs. To examine health behaviors, subject’s academic year was used as the within-subject variable, and peer contact was the between-subject variable. Significance was set at 0.05. Interaction graphs were also constructed for each of the interactions (White et al., 2009).

Eating and nutrition were investigated in relation to academic year. One significant interaction was between academic year and weight management (Wilk’s Λ=0.88, F(2,87)=8.86). The interaction graph showed that those subjects who reported contact with PHE (3.19±5.01) in the first year participated in more unhealthy weight management behaviors at baseline than those with no contact with PHE (0.93±2.04). These unhealthy behaviors of the contact group (1.87±3.30) decreased to similar levels of the no contact group (1.32±3.52) at the second year. Another significant interaction was seen between “fat talk” and academic year (Wilk’s Λ=0.91, F(2,91)=4.58). “Fat talk” is any conservation in which participants discussed topics related to weight, shape, or appearance. The interaction graph showed much higher levels of fat talk at years one (10.00±8.11) and two (10.28±7.88) for the contact group but by year three these levels significantly decreased (8.95±7.69). In the no contact group, the levels increased slightly from years 1 (5.13±5.69) through 3 (5.24±6.41) (White et al., 2009).
AOD interactions with academic year were also significant. In both groups, AOD consumption increased across all three years, but was greater in the no contact group than the contact group (Wilk’s Λ=0.91, F(2,80)=4.03). Negative consequences related to AOD consumption were also significant. Negative consequences increased from year 1 to year 3 in both groups but was greater in the no contact group (Wilk’s Λ=0.92, F(2,74)=3.23). The interaction graphs for both of these variables indicated an increase across all 3 years but also a leveling off in years two and three for the contact group as opposed to the no contact group, which was on a steady incline (White et al., 2009).

**College course to improve knowledge.** Skinner (1991) took a different approach when developing an intervention to promote nutrition behavior change in college students. The purpose of this study was to assess changes in dietary behavior of college students while they were enrolled in an introductory nutrition course to see if the changes aligned with what was being taught in the course. A professor and graduate assistant taught nutrition principles, application of the nutritional information, and improvement of dietary practices. The primary objective of the course was to motivate positive dietary changes (Skinner, 1991).

Undergraduate college students (n=286; 58 males; 228 females) enrolled in one of the three semesters in which the course was offered. One-third of the students in the course participated in a university meal plan and most students reported having adequate or more than adequate funding for food (Skinner, 1991).

The study used a pretest-posttest design where a 3-day food record was kept on Thursday, Friday, and Saturday. Students were instructed to report food intake by eating occasion such as: first eating occasion, second eating occasion, etc. As new nutrients
were taught to the class, subjects analyzed their own food intake, age, and gender, then compared it against the Recommended Dietary Allowances of 1980 (RDA). After all nutrients were taught, subjects completed a written and graphic evaluation of his/her nutrient intake (Skinner, 1991).

Mean intakes were calculated for energy, protein, fat, carbohydrates, calcium, phosphorus, iron, potassium, vitamin A, thiamin, riboflavin, niacin, and ascorbic acid. Paired t-tests were used to compare pre- and post- dietary intakes. Significance levels were set at $p<0.05$ (Skinner, 1991).

Changes in nutrient intake from pre- to posttest were only significant in females (1732±43 kcal to 1581±36 kcal), although males did experience a mean decrease of 206 kcal and 11 g of fat following enrollment in the course. This may have not been significant because male subjects were already meeting the RDA for nutrient intakes. Mean calories from alcohol decreased from 132 to 73 in male subjects and 31 to 10 in female subjects (Skinner, 1991).

Female data also suggested a significant decrease in fat (69±2 to 63±2) and carbohydrates (205±6 to 186±5), as well as a significant increase in calcium (704±22 to 776±30), potassium (2109±49 to 2243±63), vitamin A (4587±291 to 5793±371), and ascorbic acid (86±4 to 101±5) following the course. Mean nutrient intake of calcium and iron for females remained below RDA pre- and post- intervention. Overall, both groups experienced a decrease in kcal following the nutrition course. In addition to decreasing kcal, subjects also maintained their vitamin and mineral intake levels, which indicates that subjects were consuming more foods that were rich in nutrients (Skinner, 1991).
Ha and Caine-Bish (2009) also investigated the effects of a general nutrition course on college students’ eating behaviors. The main objectives of this study were to assess the current intake of fruits and vegetables in a sample of college students, and to evaluate the effectiveness of participation in a 15-week basic nutrition class in increasing the consumption of fruits and vegetables of college students (Ha and Caine-Bish, 2009).

Eighty college students between the ages of 18 and 24 years old were recruited from a Midwestern university. Eligible subjects had to be healthy and free of any dietary restrictions. The pretest-posttest design was implemented around the nutrition class intervention. The pretest and posttest comprised a 50 minute interview where anthropometric data were collected and the accuracy of the subject’s food record was verified. Dietary intake was assessed with a three day dietary record where subjects noted food consumption on 2 week days and 1 weekend day. The intervention consisted of three, fifty minute classes, per week for fifteen weeks. The classes included hands on activities and focused on nutrition content related to: (a) the importance of nutrition related to prevention of chronic disease; (b) increasing consumption of fruits, vegetables, and whole grains; (c) promoting consumption of low fat dairy products; (d) discourage overreliance on dietary supplements; and (e) promoting an active lifestyle (Ha and Caine-Bish, 2009).

Food consumption was compared to the MyPyramid food guidance system and the Centers for Disease Control and Prevention guidelines. ANOVA was used to assess differences in pretest and posttest measures, and paired t tests were conducted to compare overall differences in fruit and vegetable consumption. Significance was set at $p<0.05$ (Ha and Caine-Bish, 2009).
No significant differences in fruit and vegetable consumption were detected between genders, place of residence, or years in college. Therefore, data were pooled and revealed significant differences in mean fruit and vegetable intake after enrollment in the course. Significant increases in mean cups of fruit (0.94±0.92 to 1.33±0.99) and fresh fruit (0.43±0.61 to 0.99±0.85) intake from pre- to posttest were expressed. Mean vegetable (0.77±0.62 to 1.52±1.03) and fresh vegetable (0.46±0.50 to 1.2±0.93) consumption from pre- to posttest also increased significantly (Ha and Caine-Bish, 2009).

Other variables that were measured were starchy vegetables, canned fruit, fruit juice, vegetable juice, and french fries. Although changes were not significant, starchy vegetables (0.30±0.33 to 0.29±0.40), canned fruit (0.06±0.15 to 0.05±0.15), and fruit juice (0.45±0.64 to 0.32±0.47) all decreased slightly. French fry consumption decreased significantly (0.15±0.28 to 0.07±0.15) and vegetable juice consumption increased slightly (0.01±0.07 to 0.02±0.15) following enrolment in the course (Ha and Caine-Bish, 2009).

Ha and colleagues further studied the consumption of other nutrition components such as milk and soft drinks (Ha, Caine-Bish, Holloman, & Lowry-Gordon, 2009) and whole grains (Ha & Caine-Bish, 2011). The objectives of the study were similar to that of the previous work with different variables to assess soft drink and milk consumption, and to evaluate the effectiveness of a 15-week class-based nutrition intervention in changing beverage choices among college students (Ha et al., 2009). Data collected from a previous study of college students nutrition behavior change was further studied (Ha & Caine-Bish, 2009).
The data were analyzed using repeated measures ANOVA (Ha & Caine-Bish, 2009). Gender was the between-subject variable, while time was the within-subject factor. This was compared to consumption of total soft drink, regular soft drink, diet soft drink, total milk, low-fat milk, and fat-free milk pre- and post-intervention. Significance was set at $p<0.05$ (Ha & Caine-Bish, 2009).

Overall, changes in consumption of soft drinks and milk were identified from baseline to post-intervention. Mean total soft drink consumption (fl.oz) significantly decreased (6.73±1.30 to 4.18±0.95) from pre- to posttest. Although no significant changes for mean diet soft drink consumption were present (3.31±1.11 to 2.04±0.79), the change for regular soft drink consumption was trending towards significance (3.72±0.86 to 2.30±0.72). Changes in mean total milk consumption were not significant for the sample, although consumption did significantly increase for females (4.18±0.71 to 6.23±0.85). Mean total low-fat milk consumption significantly decreased post-intervention (4.17±0.84 to 1.90±0.77), due to the behavior change in males consuming significantly less low-fat milk (6.18±2.42 to 1.70±1.11). This behavior change was countered with a significant increase in mean total fat-free milk consumption (1.06±0.71 to 4.23±1.18) and was greatest in females (1.67±0.51 to 3.54±0.78). Although a decreasing trend was identified, no significant differences were calculated in whole milk consumption (0.29±0.44 to 0.07±0.19) (Ha & Caine-Bish, 2009).

In reference to the evaluation of whole-grain consumption, the purpose of this study was to estimate current consumption of whole-grains and determine if there would be a change in whole-grain intake following completion of an interactive introductory nutrition course focusing on disease prevention in college students. The data that were
collected in the previously discussed study were analyzed using repeated measures ANOVA. These were used to identify differences in grain, whole-grain, product fiber, and energy intake between genders. Significance was set at $p<0.05$ (Ha & Caine-Bish, 2011).

No significant differences between males and females were determined in overall grain consumption at pre- and post-intervention measures. Therefore, the data for all subjects were pooled. Overall, total grain and whole-grain consumption were low at pre-intervention. Whole-grain consumption (oz) increased significantly from pre-to post-intervention (0.4±0.6 to 1.2±1.0), while total grain intake remained low (3.1±3.1 to 3.1±3.0). At the initiation of the study, it was also observed that 49% of subjects consumed some whole-grain products and, by the end of the course, this value increased to 80%. There was also an increase in consumption of the recommended amount of whole-grain intake, 3 oz, from 1% to 13% pre-to post-intervention. Significant changes were also identified in mean total energy (kcal) intake where total energy decreased (2,270±763.7 to 1,764±551.4) (Ha & Caine-Bish, 2011).

Matveinko, Lewis, and Schafer (2001) also evaluated the effects of a college course on nutrition behavior, although this intervention incorporated lecture and laboratory components. In the lecture, students were taught the scientific principles of energy consumption and conversion, genetics, food composition, diet, and physical activity. During the classroom activities, students practiced estimating basal metabolic rate, body composition, fat distribution, energy expenditure, and fat use for various physical activities. In laboratory activities, students practiced measuring body
composition, serving sizes, food sensory with low- and high-fat foods, and food
preparation methods (Matveinko et al., 2001).

Freshman and sophomore female undergraduate college students (n=40)
participated in the college course for two credits. Subjects were excluded if they had
prior nutrition education. The researchers hypothesized that nutrition courses that stress
fundamental principles of human physiology, energy metabolism, and genetics will help
prevent weight gain during the first 16 months of college life (Matveinko et al., 2001).

Subjects were randomly split into two groups, intervention (n=21) and control
(n=19). Body weight, height, nutrient intakes, and knowledge were measured at baseline,
at the completion of the course (month 4), and 1 year following (month 16). Dietary
intake was measured using a 116-item semi-qualitative food frequency questionnaire, and
knowledge was assessed through a standard multiple choice and short answer exam
(Matveinko et al., 2001).

The data were analyzed using repeated-measure ANOVA, with groups as
between-subject factors and times of measurement as a within-subject factor. If
significant during the primary analysis, a secondary analysis of independent sample t-
tests was conducted. Significance was set at α<0.05 (Matveinko et al., 2001).

The intervention college course did indicate significant differences between the
experimental and control group. Mean total knowledge increased in the intervention
group at four months (+2.2±1.5), significantly more than the control group (+1.0±0.2).
At sixteen months, there was slight decrease in knowledge scores for both groups, but the
intervention group’s score (1.8±1.3) still remained significantly higher than the control
(+1.1±1.3) (Matveinko et al., 2001).
In reference to dietary intake at four months, the intervention group consumed less kilocalories (k/cal) per day (2055.8±893.3 to 1729.8±691.2) while the control group consumed more (2,171.6±1,206 to 2,244.3±1,000). Energy intake per kilogram of bodyweight was also significantly lower in the intervention (30.6±11.7 to 26.0±9.8) group while the control slightly increased in weight (34.2±19.2 to 35.3±17.0). The decrease in energy intake in the intervention group was due to the decrease in total carbohydrate (g/d) (266.2±96.8 to 227.9±104.5), protein (g/d) (80.6±24.3 to 68.2±21.9), and fat intake (g/d) (72.2±58.2 to 59.2±39.2). Although this was not significant, the intervention group was consuming 23 less grams of fat per day than the control group at sixteen months ($p$ value not reported) (Matveinko et al., 2001).

Results indicated no significant difference in body weight or BMI between the groups until the groups were split based on BMI; desirable BMI (22) and high BMI (28). Those with a high BMI in the intervention group experienced the most significant changes. Compared with those with a high BMI in the control group who consumed 319 more k/cal per day, those with a high BMI in the intervention group consumed 548 k/cal fewer per day at month four. This difference was due to the intervention group’s significant decrease in consumption of fat (83.5±74.1 to 57.4±46.7), carbohydrates (283.5±91.6 to 232.4±115.9), and protein (87.9±19.6 to 66.9±27.9) at four months. Those with a high BMI in the intervention group also consumed less of their energy from fat (29.9±11.1 to 21.6±9.7). At 16 months, those with a higher BMI in the intervention group lost an average of 1.4 kg while those in the control group gained an average of 9.2 kg (Matveinko et al., 2001).
From this intervention, it can be determined that education was successful for changing the long term behaviors of those college students who are already at risk due to a high BMI. We do see an immediate effect in the data collected after the completion of the program, but the significance seems to dissipate over the years following (Matveinko et al., 2001).

The previously discussed changes in healthy food consumption in response to educational intervention indicate a clear benefit of nutritional education that is disease and behavior specific. The benefits discussed are short-term effects of self-report behavior, and may not have long term benefits for lifestyle change. Although it is clear that knowledge relates to behavior, more empirical research should be conducted to determine if long term benefits are conclusive.

**Knowledge: Perceived seriousness and susceptibility.** Knowledge is also a modifying variable that can indirectly impact behavior. Knowledge can influence perception of their susceptibility to a disease and how severely that disease can affect them. The literature lacks any studies that investigate knowledge of T2D associated with behavior in a college student population. However, there are a few recent studies that do investigate college students’ motives to make a behavior change through the HBM. These studies evaluate the immediate effects of their perceptions on their health behaviors (Das, & Evans, 2014; Deshpande, Basil, & Basil, 2009; Downing-Matibag & Geisinger, 2009).

Many studies have used the HBM to guide their research, but few have used it to examine the college population. The most recent studies of college students using the HBM have been focused on nutrition and physical activity behaviors (Das & Evans,
2014; Deshpande, Basil, & Basil, 2009). Other studies that investigate college students focused on risky behaviors (Downing-Matibag & Geisinger, 2009).

In addition to literature that focuses on college students, there have also been studies that investigate the behaviors and perceptions of healthy, non-diabetic subjects. Generally, this research has been limited to children, young adolescents, and middle age, at risk, adults (Divakaran et al., 2010; Gordon, Walker and Carrick-Sen, 2013, 2014). These studies have found significant associations between lack of knowledge and poor health behavior, possibly due to a disconnection between perceived seriousness and/or susceptibility to T2D. This lack of knowledge may be what clouds their view of the risks associated with poor health behaviors, thus, they continue to practice them.

**College students.** Deshpande, Basil, and Basil (2009) tested the predictive value of the HBM with respect to the likelihood of college students eating healthily. Ten hypotheses related to importance of healthy eating and the variables of the HBM were tested against the likelihood of healthy eating. More specifically, the hypothesis that is most closely related to individual perceptions was “healthy eating will be positively influenced by perceived severity and perceived susceptibility related to disease” (Deshpande et al., 2009).

One hundred and ninety-four undergraduate students (18-24 years old) from a Canadian university participated in this study. All subjects completed a HBM survey consisting of 7-point bipolar scale questions that assessed individual perceptions of independent variables. These variables were all related to constructs of the HBM, such as perceived susceptibility and perceived seriousness. An example of a perceived seriousness question was, *If ill, I will miss more than two months of school or work,* and
an example of a perceived susceptibility question is, *Do you think some day you will get seriously ill if you do not make good food choices.* Importance of eating healthy was an additional independent variable. It was measured by asking “*How important is it to you to eat a diet high in nutrition?* and *How important is nutrition to you when you shop for food?*” (Deshpande et al., 2009).

The dependent variable, likelihood of healthy eating, was the behavioral outcome variable. This variable was measured with the following statements: (a) I intend to eat a nutritious diet most of the time in the next two weeks, (b) In the course of the next two week period, how often will you make good food choices (never/every meal), and (c) In the course of the next two-week period, how often will you make good food choices (never/always). All responses were analyzed using Pearson correlation analysis to compare independent and dependent variables (Deshpande et al., 2009).

Findings suggested that perception of the importance of healthy eating was predicted by perceived susceptibility (mean=5.18±1.56, $\beta=0.16$), and perceived severity (mean=4.85±1.22, $\beta=0.17$). The importance of eating healthy was also a predictor for the likelihood of eating healthy ($r=0.57$) (Deshpande et al., 2009).

When the sample was split by gender, some of the previous trends disappeared. With reference to the female dataset, perceived severity (mean=4.77±1.25, $\beta=0.27$) and the likelihood of eating healthy ($r=0.82$) were still significantly correlated with the importance of eating healthy while perceived susceptibility lacked significance (mean=5.27±1.54, $\beta=0.10$). In reference to the male dataset, perceived susceptibility (mean=5.09±1.57, $\beta=0.23$) and the likelihood of eating healthy, ($r=0.45$) were both still
significantly correlated with the importance of eating healthy, while perceived severity lacked significance (mean=4.93±1.20, β=0.12) (Deshpande et al., 2009).

Overall, it can be seen that the importance of eating a healthy diet significantly impacts the likelihood of participating in that behavior. For females, this belief of importance can be influenced by their perceived severity, while males are more influenced by their perceived susceptibility to an illness (Deshpande et al., 2009).

Das and Evans (2014) used a qualitative approach for their study. A nominal group technique and the HBM were used to examine health perceptions in first year college students. The purpose of this study was to examine first year students’ perceptions of their weight management beliefs and challenges on the college campus. Students (n=45) participated in a four step protocol where subjects: (a) responded to a question derived from the HBM in reference to physical activity and nutrition, (b) participated in a written round robin feedback session where students wrote responses on paper, (c) discussed their answers, and (d) voted on responses to reflect answers that were reflective of the majority of the population. More specifically, questions were related to perceived susceptibility and perceived severity (Das and Evans, 2014).

Overall, the data suggest that first year college students were concerned with perceived susceptibility and severity as a result of being inactive or eating poorly. The students thought this would affect several aspects of their lives. More specifically, subjects believed being inactive or eating poorly would increase their susceptibility to poor physical and mental health, decreased QOL, and poor self-esteem. Males were most concerned with physical health, mental health, and their romantic life, while females
were more concerned with a declining physical health in terms of disease, QOL, and weight gain that would compromise their beauty (Das and Evans, 2014).

In reference to perceived seriousness, subjects were most affected by the possibility of decreased QOL, seeing family members and friends suffer from poor health behavior choices, and the impact on their self-esteem and confidence. Males were most concerned about decreasing their QOL, the financial risks, and career risks. Females were more concerned with increased risk of health problems, decrease in QOL, and limited independence (Das and Evans, 2014).

Overall, many responses were related to a concern for their QOL, physical health, and mental health. Subjects also expressed a concern for the barriers such as time and knowledge/skill to participate in the behaviors, although they did suggest cues to action that could be used in a weight management program. This will be discussed in a later section (Das and Evans, 2014).

Downing-Matibag and Geisinger (2009) investigated college students’ risky behavior. The purpose of this qualitative study was to gain a more thorough understanding of the concept of *hooking up*, or sexual activity, through the college students’ perspective using the HBM. More specifically, researchers wanted to identify perceived seriousness and susceptibility of risk factors associated with sexual activity such as sexually transmitted infections (STI) (Downing-Matibag and Geisinger, 2009).

Undergraduate college students from a Midwestern university (n=71; 32 males; 39 females) were recruited for this study. All subjects were between 18 and 24 years old (mean 19.5 years) and participated in sexual activity with someone to whom they had no relational commitment. Following an interview screening to confirm subjects met the
criteria, each subject participated in a private, 45 minute, interview session with one of the four members of the research team. The interview consisted of four phases where they discussed: (a) their own perceptions of sex and dating norms on campus, and what they believed their friends and peers believed about sexual activity in college; (b) events that occurred with their most recent sexual encounter; (c) overall experience of most recent sexual experience; (d) perceptions of sexual risk taking during the sexual encounter with respect to STIs (Downing-Matibag and Geisinger, 2009).

All interview sessions were tape recorded, transcribed, and coded. The first author then checked for accuracy. Microanalytic context analysis was used to identify key factors associated with protective barriers to prevent STIs. Global content analysis was also used to identify components of the HBM that were discussed during the interview (Downing-Matibag and Geisinger, 2009).

Perceived susceptibility and seriousness were both identified as trends in the data. Overall, students were unaware of their own vulnerability to STIs. They did not believe they were at risk. Only 50% of subjects were concerned about contracting an STI during a sexual encounter. Trends suggested that this lack of concern was due to a high level in trust of their partners not having a STI, a high level of trust that that there was a low prevalence of HIV/AIDS in their community, and being inadequately informed of the risk. Each of these trends is directly related to lack of knowledge regarding risk factors for STIs. This lack of knowledge lowers the believed threat and reducing their likelihood to participate in risk preventing behaviors (Downing-Matibag and Geisinger, 2009).

**Children and adolescents.** One recent study focused on risk factors associated with T2D and other noncommunicable diseases (NCD) in a younger population
The aim of this study was to evaluate what children and adolescents knew regarding risk factors for NCDs, including cancer, cardiovascular disease, and T2D. A random sample of 375 male and female children, from a rural government school, in Kerala state, India was chosen to take a structured, closed-ended, self-administered questionnaire. The questionnaire consisted of topics related to health behavior sociodemographic characteristics and the three NCDs. After scoring the questionnaires, subjects were grouped into high awareness, if they correctly answered more than 60% of the questions; medium awareness, if they correctly answered between 30% and 60% correctly, and low awareness, if they answered less than 30% correctly. The reported responses were then analyzed using frequencies and proportions (Divakaran et al., 2010).

Results related to adolescent knowledge of NCDs indicated that 84.8% of subjects had a low awareness of NCDs and their risk factors, while only 0.08% had a high awareness. Only 53.1% of subjects had ever heard of T2D, and 37.2% thought it was a public health concern. Similar trends were seen in subjects’ perception of seriousness related to cancer (32%) and cardiovascular disease (18.9%) (Divakaran et al., 2010).

With reference to behavior, only 27.7% of subjects reported daily physical activity. A few students recorded the recommended consumption of fruits and vegetables (25.3%) while many consumed more than the recommended amount of soft drinks daily (33%). Although significance cannot be determined due to a need for further analysis of the data, we still see a commonality between lack of knowledge concerning risk factors of NCDs, especially related to seriousness of the disease, and poor health behaviors (Divakaran et al., 2010).
Ultimately, adolescents are unaware that their current behaviors may impact their future. This deficiency of knowledge may also be related to their lack of concern related to the seriousness and individual susceptibility to T2D, because they do not believe it has an immediate impact on them.

**Diabetic and at-risk subjects.** Gordon, Walker and Carrick-Sen (2013; 2014) explored the knowledge and perception of T2D in a healthy population that carries a genetic risk for T2D. Subjects in the studies consisted of six (4 males; 2 females) 21-38 year old offspring of patients with T2D from the United Kingdom. Subjects were generally healthy, two were obese, and two overweight. Even though currently healthy, having a diabetic parent puts this population at greater risk of T2D (Hjelm, Mufunda, Nambozi, & Kemp, 2003). All subjects were interviewed from January through March 2011. The interview questions consisted of questions regarding T2D and perceptions of risk, knowledge, lifestyle behaviors to reduce risk, and strategies to improve knowledge.

The primary aim in one study by Gordon et al. (2014) was to gain a better understanding of the knowledge of a population that carries a genetic risk component for T2D. Following an analysis of the semi-structured interviews, the following themes were identified: risk, knowledge, and motivation to change behavior to reduce risk of T2D. Findings suggested that subjects did possess the knowledge for proper nutrition and exercise to reduce T2D but did not have sufficient knowledge regarding individual risk of T2D and its seriousness. Subjects believed T2D was a part of getting older and did not classify it as seriously as they did a heart condition or stroke. Ultimately, subjects lacked motivation to make any lifestyle changes because they were unaware of the seriousness of the link between T2D and their individual genetic risk (Gordon et al., 2014).
In another analysis using the same data, Gordon et al. (2013) assessed knowledge and action to reduce risk, or behavior. Evidence concluded that the population had basic knowledge of T2D, because subjects related T2D to balanced sugar levels, weight gain, and poor diet. Subjects also understood healthy behaviors related to T2D such as physical activity, healthy diet, and weight management. Where subjects were lacking in knowledge was T2D’s association with genetics and their own risk. This lack of knowledge concerning T2D may have altered their perceptions, and resulted in poor behavior. Due to the small sample size, these results just allow us a glimpse into the knowledge and perception of those at risk of T2D (Gordon et al., 2013).

Diabetic patients are at an increased risk of severe complications if they do not adhere to physician’s regimens. Bloom and Hart (1980) investigated the relationship between the compliance levels of persons with T2D regarding the specific aspects of their medical regimen and the HBM constructs. Subjects were all diabetic patients (n=30) who were being treated with insulin, 18 years or older, responsible for their own care, and spoke English. It was also required that subjects followed a physician’s regimen which indicated that they had the preexisting knowledge of how to manage their T2D (Bloom and Hart, 1980).

In-home interviews were conducted for all subjects to gather information regarding patients’ compliance and health beliefs. A 23-item compliance measurement tool was implemented. Compliance with insulin administration, compliance with glucose monitoring, urine testing, and foot care were all evaluated through direct observation and self-report. Diet compliance was only estimated through self-report. A 15-item health
belief measurement tool was used to measure perceived susceptibility, and perceived seriousness. A Likert scale was used to assess each item (Bloom and Hart, 1980).

Correlation results indicated significant associations between HBM predictors and compliance with medical recommendations ($r=0.50$). More specifically, subjects who perceived their diabetes to be serious were more likely to be compliant with their regimen than those whose perceptions were less serious ($r=0.40$). This trend was most significant in compliance with foot care ($r=0.47$). As a whole, perceived susceptibility was not significantly correlated with compliance, although it was strongly associated with having the necessary tools to control and monitor glucose and insulin levels ($r=0.48$) (Bloom and Hart, 1980).

Sharifirad, Entesari, Kamran, and Azadbakht (2008) also investigated a diabetic population and the influence of the HBM on their behaviors. More specifically, the researchers examined the effectiveness of the HBM on nutrition education in T2D patients. Eighty-eight Iranian, T2D patients, between 30 and 60 years old were recruited for this study. Subjects were required to have been attending Iranian Diabetes Association seminars for at least 1 year, be literate, and have no severe or chronic complications of their condition (Sharifirad et al., 2008).

The subjects were split into control ($n=44$) and intervention ($n=44$) groups. The intervention consisted of four education sessions that were each 40 minutes in length. During the education sessions, nutrition was taught based on the World Health Organization and American Diabetes Association standards. The lessons focused on food exchange to improve nutrition (Sharifirad et al., 2008).
Pre- and post-intervention subjects were asked to complete a questionnaire. The questionnaire consisted of 58 questions on topics related to demographics, nutrition knowledge, HBM components, and nutrition practice. Paired t-tests were used to compare the mean group changes for the variables. Significance was set at $p<0.05$ (Sharifirad et al., 2008).

Overall, mean knowledge increased significantly in the intervention group (57±16 to 80±11). Knowledge was not significantly different between groups at the start of the study, although post-intervention, the knowledge of the intervention group was significantly greater than that of the control and knowledge actually decreased in the control group (54±14 to 52±13) (Sharifirad et al., 2008).

In reference to the variables, all construct variables increased significantly in the intervention group from pre- to post-intervention. The mean difference pre- to post-intervention for: perceived susceptibility was (29.6±18.5), perceived severity (27.5±18.5), perceived benefits (21.1±16.3), and perceived barriers (-14.7±13.3). The increase in knowledge in the intervention group was also significantly greater than that of the control group which had slight increases in perceived severity (3.9±17.2) and perceived barriers (0.9±13.9), and slight decreases in perceived susceptibility (-2.6±14.0) and perceived benefits (-3.1±18.9) (Sharifirad et al., 2008).

As seen in this study, perceived susceptibility and perceived severity are not the only two constructs of the HBM influenced by knowledge. Perceived barriers and benefits should also be considered. The following literature focuses on how improving knowledge may increase the perceived benefits, and decrease perceived barriers to making a positive behavior change.
Knowledge: Perceived benefits vs. perceived barriers. Knowledge concerning diabetes risk factors and prevention through healthy lifestyle behavior has also been well-studied in diabetic and pre-diabetic populations (Social & Scientific Systems, Inc., 2009). In the HBM, knowledge is a modifying factor that directly impacts perceived benefits and barriers of preventive action which, in turn, determines the likelihood of action (Figure 1.1). Knowledge regarding T2D is the degree to which individuals understand the implications of the disease and how to take preventive action. Behaviors associated with T2D are the actions that modify health status, including physical activity and eating habits. Behavior is of great concern in preventing T2D (Social & Scientific Systems, Inc., 2009).

College students. Kim, Ahn, and No (2012) investigated nutrition behavior of college students. The purpose of this study focused on nutrition beliefs and how the beliefs impacted health behavior intention. Hypotheses 2c and 2d proposed that college students with confidence in their nutritional knowledge would have strong nutrition beliefs that would impact their perceived barriers and benefits. Hypothesis 3e, 3f, 3g, and 3h proposed relationships between benefits and barriers, and behaviors. The behaviors included healthy eating and participating in physical activity (Kim et al., 2012).

A structured online survey was administered to 251 college students between the ages of 18 and 25 (mean age= 21.98). The survey consisted of questions related to constructs of the HBM and included nutritional confidence, benefits, barriers, and behavioral intentions to eat healthily and participate in physical activity. Relationships among these variables were investigated using multivariate analysis (Kim et al., 2012).
Findings suggested that nutritional knowledge did impact confidence ($r=0.16$), and confidence significantly impacted barriers ($r=0.28$) and benefits ($r=0.35$). In turn, benefits and barriers were significantly correlated with eating healthy (benefits, $r=0.15$; barriers, $r=0.20$) and participating in physical activity (benefits, $r=0.28$; barriers, $r=0.24$). Overall, results supported the HBM and showed that a high perceived benefit and low perceived barriers regarding healthy food consumption may lead to a positive behavior change for eating and physical activity (Kim et al., 2012).

Greaney and colleagues (2009) investigated the barriers that college students face related to healthy eating and participating in physical activity. The purpose of this study was to identify the barriers for healthy weight management among college students in hopes of implementing an on-campus program that is geared towards overcoming the identified trends (Greaney et al., 2009).

Students from eight U.S. universities were recruited to participate in the qualitative study. All subjects were required to be full-time college students, between the ages of 18 and 24, and majoring in nutrition or exercise science. One hundred and fifteen subjects (54.8% females) met the criteria and participated in 16 online focus groups. The focus groups were homogeneous by sex and university. The questions in the focus groups were designed to elicit a conversation among subjects regarding issues that are of importance to this population such as: semester goals, managing weight, triggers to eating, regulating food intake, and concerns about body shape and size. In addition to the focus groups, subjects completed three questionnaires. An International Physical Activity Questionnaire (IPAQ) was used to assess participation in physical activity, a
two-item fruit and vegetable screener evaluated food intake per day, and a self-report survey for height and weight to calculate BMI (Greaney et al., 2009).

The data from the focus groups were transcribed and coded. Trends related to barriers to weight management were identified and grouped into intrapersonal, interpersonal, and environmental categories. Physical activity and intake of fruits and vegetables were presented using the descriptive statistics means, standard deviations, and frequencies. Chi square and ANOVA were used to identify differences between genders (Greaney et al., 2009).

Findings suggested that, overall, subjects had a desire to be healthy and participate in healthy eating and physical activity. Although a healthy desire was present, the subjects also expressed a concern of being faced with several intrapersonal, interpersonal, and environmental barriers (Greaney et al., 2009).

When considering both male and female responses, intrapersonal barriers to maintain a healthy weight included lack of exercising, eating unhealthy foods, temptation, lack of discipline, and being bored. The most common intrapersonal barriers for both genders were lack of exercise. Males were more concerned with weight lifting exercises, and females were more concerned with gaining weight as a result of the lack of exercise (Greaney et al., 2009).

Interpersonal barriers to maintaining a healthy weight for both groups were social situations and the social pressures to eat. Alcohol was also expressed as a barrier and that “drunk eating” made weight control difficult. Subject groups also agreed on all environmental barriers to healthy weight management. These barriers included time constraints of being a student; unhealthy food served in dining halls; easy access to
unhealthy food, such as fast food; lack of access to healthy food due to location of
grocery stores; and a limited financial budget. When considering barriers to healthy
behaviors to maintain weight in college students, gender is only important in
intrapersonal aspects. These barriers may be different when considering other motives to
participate in healthy behavior, such as prevention of chronic disease later in life
(Greaney et al., 2009).

**Diabetic and at-risk subjects.** Diabetics and pre-diabetics are usually made aware
of their condition through interaction with a health care professional. When diagnosed,
the health care professional discusses lifestyle changes to help manage the condition.
These changes should include recommendations for an increase in physical activity,
consumption of healthier food options, and a decrease in body weight. Research has
revealed that when diabetic and pre-diabetic individuals are aware of their condition, and
how to manage it, they are more likely to make positive lifestyle behavior changes
(Tuomilehto et al., 2001).

Tuomilehto et al. (2001) followed a population from Finland that was at risk for
developing T2D, to see if an educational intervention could help prevent the onset of the
condition. The male and female subjects in the study were all at high risk for diabetes.
The subjects were screened for a genetic history of diabetes (T1 and T2), a BMI of at
least 25, age between 40 and 65 years, and impaired glucose tolerance. Impaired glucose
tolerance was defined as a plasma glucose concentration of 140-200 mg per deciliter of
blood two hours post oral administration of 75 g of glucose, and those whose plasma
glucose, following an overnight fast, was less than 140 mg per deciliter (Tuomilehto et
al., 2001).
Subjects (N=523) were randomly assigned to control (n=247) and intervention groups (n=253). All subjects attended baseline and annual measures for BMI, waist and hip circumference, plasma lipids and glucose levels, and blood pressure. In addition to the physical measurement, subjects also participated in an interview process where their nutritional and physical activity behavior was discussed. During these sessions, the control group was administered reading material concerning nutrition and physical activity, while the intervention group participated in educational classes about weight loss, reducing and modifying fat consumption, increasing fiber intake, and participation in physical activity. Each subject in the intervention group had seven individualized classes the first year, and one class every three months thereafter, for 3.2 years. The sessions were directly tailored to the health needs of each subject in the intervention group (Tuomilehto et al., 2001).

Data were analyzed using 2-tailed t-tests and chi-square tests to identify differences between control and intervention groups. Subjects in the intervention group experienced significantly better results than the control group at the end of the first year for weight (-4.2 kg±5.1, CI=-4.8 to-3.6), waist circumference (-4.4 cm±5.2, CI=-5.1 to-3.9), change in fasting plasma glucose (-4 mg/dl±12, CI=-6 to-2), change in plasma glucose 2 hours after oral glucose test (-15 mg/dl±34, CI=-19 to-11), change in serum insulin 2 hours after oral glucose test (-29 µg/ml±64, CI=-37 to-21), and triglyceride levels (-18 mg/dl±51, CI=-24 to-12). Changes in systolic (-5 mmHg±14, CI=-7 to-3) and diastolic (-5 mmHg±9, CI=-6 to-4) blood pressure were also significant after 1 year and indicated a reduction towards healthier levels. By the end of year 2, the mean weight loss of the experimental group (3.5±5.5 kg) was still significantly more than the control group.
(0.8±4.4 kg). No significant changes were reported at the end of year 2 or 3 for behaviors (Tuomilehto et al., 2001).

Results regarding nutrition and physical activity behavior after 1 year indicated that the percent of subjects in the intervention group (55%, 87%) were significantly more successful than the control group (40%, 70%) in decreasing fat and sugar consumption, and changing the quality of fat they consumed (70% and 39%). In the intervention group, 72% of subjects increased their vegetable consumption, 59% decreased their salt intake, and 26% decreased their alcohol consumption. Additionally, 36% of subjects in the intervention group significantly increased participation in exercise. From these results, we can conclude that sufficient education and knowledge is important for those at risk of T2D. Participants learned the importance of healthy behaviors and demonstrated that these benefits outweighed the barriers in preventing them to make the change (Tuomilehto et al., 2001).

Knowledge has been discussed as an influential modifying variable that can impact threat, perceived susceptibility, perceived seriousness, perceived barriers and preventive action. There are also two other modifying variables that impact these same constructs: demographics and psychosocial variables.

**Demographics: Health Behaviors**

According to the HBM in Figure 1.1, demographic variables can impact threat, perceived susceptibility, perceived seriousness, perceived barriers and preventive action. Literature suggests that individuals who possess these specific demographics, such as level of education, income, race, ethnicity, and gender, may be more amenable to
behavior change (Davy, Benes, & Driskell, 2006; Sakamaki, Toyama, Amamoto, Liu &
Shinfuku, 2005).

Level of education. In the HBM level of education has been referred to as a
demographic variable that may impact an individual’s likelihood to participate in healthy
behaviors. The association between level of education and participation in healthy
behaviors may be important because knowledge, another modifying variable, may be
linked to number of years spent in an educational institution. It has previously been
discussed in this paper that knowledge appears to influence behavior. What has not been
discussed is if education impacts knowledge. If so, then does level of education impact
health behavior?

As discussed in an earlier section, Avis, McKinlay, and Smith (1990) studied the
CVD knowledge of 732, 25-65 year old subjects and their health behaviors. In-home
interviews, measurements and questionnaires were used to measure and collect data from
all subjects. Subjects in the study had varying education levels: did not graduate high
school (n=40), high school graduates (n=124), some college or technical school (n=229),
college graduate (n=127), and advanced degree or study (n=203) (Avis et al., 1990).

Stepwise multiple regression analysis was used to assess associations between
knowledge and independent variables, such as education. Total knowledge was
significantly correlated with level of education (r=0.26). More specifically, level of
education was significantly associated with awareness of cutting fat and cholesterol
(β=0.478, SE=0.105), controlling weight (β=0.310, SE=0.101), and engaging in exercise
(0.290, SE=0.107) (Avis et al., 1990).
Tamirat, Abebe, and Kirose (2014) specifically studied knowledge and its impact on physical activity. As mentioned in a previous section, the purpose of this study was to investigate predictors of physical activity among T2D patients based on the HBM. T2D subjects (n=319) from southwest Ethiopia completed a questionnaire that measured knowledge of diabetes, knowledge of physical activity, and the likelihood to participate in physical activity. Fifty-two subjects were unable to read or write, 94 subjects had below a sixth grade education, 63 subjects were educated between grades 6 and 12, and 110 subjects had greater than a 12th-grade education (Tamirat et al., 2014).

Multiple logistic regression analysis was used to identify demographic variables that were strong predictors of the likelihood for participation in physical activity. Significant associations were identified between educational status and the likelihood to engage in recommended physical activity. Subjects with an education level about grade twelve were 4.3 times more likely to participate in physical activity [AOR=4.3, 95% CI (0.29, 3.12)] than those who were unable to read and write. In addition to education, income was also a significant predictor of the likelihood to participate in recommended physical activity (Tamirat et al., 2014).

The results of the previous studies identify the need to consider level of education in behavior change. This is especially important when referring to health behaviors because of the level of knowledge required to reflect on outcomes related to seriousness, susceptibility, benefits, and barriers (Tamirat et al., 2014).

**Income.** Educational status may also impact income. Individuals with more education may be more likely to get higher paying jobs. Income is another demographic
variable that may impact an individual’s overall intention and/or ability to participate in healthy behaviors.

Tamirat, Abebe, and Kirose (2014) investigated the impact of various demographic variables on the likelihood of individuals to participate in physical activity. Knowledge and education level were two variables that were mentioned previously. Income is another demographic variable that may impact physical activity behavior. The average monthly income of subjects in this study was $876.5 \pm 62.2$ ET Bir, or $47.1$ United States dollar. Subjects were considered low income ($n=110$), middle income ($n=54$), high income ($n=23$), or very high income ($n=3$) (Tamirat et al., 2014).

Following a multiple logistic regression analysis, results indicated that middle income subjects were 11.5 times more likely to be physically active [$AOR=11.5$, 95% CI $(0.12, 0.81)$] than low income subjects (Tamirat et al., 2014).

Financial status, or socioeconomic status (SES), has also been shown to be related to nutrition behaviors (Nabhani-Zeidan, Naja, Nasreddine, 2011). The purpose of this study was to examine the different nutrient intakes among adolescents of contrasting SES in Lebanon.

Two hundred and nine Lebanese college students were recruited for the study (age 18-19 years). The subjects were grouped into high-SES ($n=110$) and low-SES ($n=99$). Subjects’ SES was determined based on the tuition of their educational institution. Those subjects who were considered high-SES attended an institution with the second to highest tuition fees in the country, while those subjects who were considered low-SES were attending an institution that provided free education. All subjects participated in three nonconsecutive 24 hour dietary recalls to assess their dietary intake. These were
conducted by a nutritionist on 2 week days and 1 weekend day. The nutritionist used a standardized interview protocol of the United States Department of Agriculture (Nabhani-Zeidan et al., 2011).

Differences in mean consumption of the various food groups were analyzed using *t*-tests. Food consumption data from the dietary recall were also converted to energy and nutrient intakes using Nutritionist IV software (N-Squared Computing). The Middle East Food Composition Tables were used to analyze data on local dishes. A general linear model, using energy as a covariate, dietary intake as a dependent variable, and SES as a fixed factor, was used to compare energy and energy-adjusted means of dietary intake between SES groups. Significance was set at *p*<0.05 (Nabhani-Zeidan et al., 2011).

Mean consumption of food groups by SES revealed that the high-SES group consumed significantly more vegetables (1.93±0.11 for high SES, 1.44±0.20 for low-SES), fats and oils (12.91±0.30 for high SES, 10.60±0.53 for low-SES), and meats (1.56±0.06 for high SES, 0.80±0.11 for low-SES) than the low-SES group. After adjusting for energy and mean nutrient intake, similar significant trends were detected. The high-SES group consumed more protein (58.52±1.30 for high SES, 49.53±2.31 for low-SES), fat (77.23±1.51 for high SES, 63.37±2.69 for low-SES), vitamin A (728.50±54.25 for high SES, 364.56±96.92 for low-SES), vitamin C (117.38±7.59 for high SES, 80.43±13.55 for low-SES), and iron (10.87±0.32 for high SES, 8.36±0.57 for low-SES) than the low-SES group. The low-SES group did consume more carbohydrates (g/day) than the high-SES group (204.74±3.64 for high SES, 245.28±6.51 for low-SES). There were no significant differences in consumption of fiber or calcium between the high and low-SES groups (Nabhani-Zeidan et al., 2011).
More specific health behaviors, such as oral health habits, have also been associated with SES. As discussed in a previous section, Laiho, Honkala, and Nyyssonen (1991) investigated the relationship between oral health habits and various lifestyle characteristics, more specifically SES. Eighteen year old subjects (n=1,010) were recruited from Finland and asked to complete a questionnaire regarding demographics and oral health behaviors (Laiho et al., 1991).

Subjects were asked about their daily tooth brushing habits, likelihood of choosing sugar-free gum products over gum with sugar, and implementation of four oral health habits. The four oral health habits included three of the previously mentioned and fluoride rinsing. In relation to SES, subjects’ SES was determined on their father’s education level. SES was considered high if the father completed more than secondary school, middle-SES if the father completed primary school and vocational education, and low-SES if the father only completed primary school (Laiho et al., 1991).

Multiple regressions were used to analyze the data, and percentages were determined for each relationship. SES was significantly correlated to brushing teeth daily. There were significant differences between the SES levels as well. The high-SES group (92% chose yes) was more likely to participate in daily teeth brushing than middle-SES (87% chose yes), and low-SES (81% chose yes). Although there were no significant relationships between SES and choosing sugar-free gum, there was a significant relationship between the four aggregated variables and SES. Subjects with a high-SES (2.5%) were more likely to implement the oral health behaviors than those in the middle-SES (2.4%) and low-SES (2.4%) groups (Laiho et al., 1991).
This literature indicated that income, or SES, does impact health lifestyle behaviors. Financial status is important to consider when discussing behavior change related to physical activity, nutrition, and overall health behaviors (Laiho et al., 1991).

**Race/ethnicity.** According to the HBM seen in Figure 1.1, race and ethnicity are also demographic variables that should be considered in behavior change. Race and ethnicity are discussed as one entity in the literature related to the HBM. Okosun, Davis-Smith, and Seale (2012) investigated populations at risk of developing T2D. More specifically, they wanted to see if non-Hispanic Whites (NHW), non-Hispanic Blacks (NHB), and Mexican Americans (MA) who are at-risk for T2D, when told of their risk, made any behavior changes to reduce their risk of T2D. The behavior changes that were examined were weight control, participating in physical activity, and reduction of fat/calorie intake (Okosun et al., 2012).

A nationally representative sample of subjects from the 2007-2008 U.S. National Health and Nutrition Examination Surveys were used for this study (n=5,073). The subjects were eighteen to 80 years old and were classified as either NHW (n=2,494), NHB (n=1,042), or MA (n=1,537). All subjects participated in in-home interviews where they completed the survey. The dependent variables were all focused around adopting a healthy lifestyle. Questions related to reducing or controlling weight, increasing physical activity, and reducing fat/calorie intake were asked. The independent variable was awareness, or being told or not being told of the risk of T2D (Okosun et al., 2012).

The data were analyzed using mean values of continuous variables that were compared across racial/ethnic groups using one way ANOVA. Prevalence differences were measured using Pearson’s χ² tests. Multiple logistic regression analyses were used
to test whether at-risk subjects were more likely to adopt healthy lifestyles than participants without risk of T2D who were told of their diabetes risk (Okosun et al., 2012).

Results indicated that overall T2D risk reduction behaviors in American adults who have no diabetes were significantly greater in NHB (16.5%) than in NHW (11.4%) and MA (15.7%). More specifically, weight control, increased physical activity, and reduced fat/calorie intake were more common in NHB (22.4%; 26.8%; 25.9%) compared with NHW (17.5%; 24.5%; 19.4%) and MA (20.7%; 26.7%; 24.4%). A similar trend was also seen in those participating in lifestyle changes in the past years. NHB were more likely to control weight (52.7%), increase physical activity (54.5%), and reduce fat/calorie intake (49.4%) as opposed to NHW (46.8%; 43.2%; 44.1%) and MA (42.0%; 41.8%; 46.6%) (Okosun et al., 2012).

Current rate of adoption of healthy lifestyle was compared to those who were told of their diabetes risk and were not told of their diabetes risk. Significant differences were seen within racial/ethnic groups. The rate of adoption of healthy lifestyle for NHW who were told of their risk for T2D was 22.7% versus 10.2% for those who were not informed. The rate was similar for the NHB and MA groups who were told of their risk (42.5%; 31.0%) and not told of their risk (14.1%; 13.9%) (Okosun et al., 2012).

A smaller study investigating physical activity in relation to racial/ethnic demographics found significant associations among the variables (Avis, McKinlay, and Smith, 1990). As previously discussed, this study investigated the physical activity behavior of 732 healthy subjects, between 25 and 65 years old, who were residents of the
Boston area. This study was concerned with the minority status of the individual rather than the specific race or ethnicity (Avis et al., 1990).

The subjects participated in an in-home interview where demographics, knowledge, and behavior measures were taken. A cardiovascular disease (CVD) risk factor awareness assessment was used to determine level of knowledge related to CVD. The Harvard Alumni scale was used to measure recreational physical activity in terms of kilocalories (kcal) expended (Avis et al., 1990).

Multiple regression analysis was used to determine the association between minority status and knowledge. Logistic regression analysis of probability was used to determine the specific steps being taken to prevent consequences of CVD. Overall, the results revealed that total CVD knowledge was significantly positively related to participation in physical activity (r=0.08). Although not significant, their results also showed that CVD knowledge is negatively related to minority status (r=-0.05). When considering behavior, the logistic regression analysis revealed that those of minority are significantly more likely to participate in exercise (β=0.902, SE=0.346) (Avis et al., 1990).

Ultimately, it is important to consider race and ethnicity when investigating behavior change, as there seems to be some relationship with the willingness and the likelihood to participate in health behaviors.

**Gender.** Nutrition behaviors among college students have been seen to have gender trends (Davy, Benes, & Driskell, 2006; Sakamaki, Toyama, Amamoto, Liu & Shinfuku, 2005). Davy, Benes, and Driskell (2006) investigated the impact of gender on nutrition self-assessment. The purpose of the study was to assess sex differences in
dieting trends and nutrition self-assessment of a group of college students. Male and female subjects (105 males, and 181 females) were recruited from an introductory nutrition course of a large Midwestern university during the fourth week of classes (Davy et al., 2006).

Subjects were asked to complete a 21-item questionnaire where they reported their participation in diets and nutritional self-assessment (Davy et al., 2006). The specific diets in question were Atkins, Weight Watchers, low-fat, low-carbohydrate, South Beach, vegetarian, and other. The nutritional self-assessment asked questions related to importance of: (a) eating a healthy diet, (b) needing more protein in diet, (c) eating too much processed carbohydrates, (d) eating too much sugar, (e) importance of nutrition content, (f) importance of eating a variety of foods, (g) importance in limiting carbohydrates, (h) importance in limiting fats for weight loss, (i) currently eating the right ratio of carbohydrates, fats, and protein, (j) importance of controlling calories for weight loss, and (k) need to lose weight. All of the data were analyzed by gender using $\chi^2$ and were considered significant at $p<0.05$ (Davy et al., 2006).

Overall, results showed some significant differences in dieting and nutrition self-assessment between genders. In relation to dieting, only 13% of subjects were currently on a diet and a significantly larger percentage of male subjects than female reported never dieting (79.1% vs 65.6%). A significantly higher percentage of female subjects than male have actually participated in Weight Watchers (6.6% vs 1.0%), low-fat diets (19.3% vs 7.6%), low-carbohydrate diets (15.5% vs 6.7%) and vegetarian diets (4.4% vs 0%) (Davy et al., 2006).
In relation to nutrition, significant differences were seen between male and female subjects’ self-assessment and beliefs. Females were more likely than males to believe that they ate too much sugar (59.7% vs 41.9%), that it is important to limit carbohydrate consumption (46.4 vs 27.6%), that it is important to limit the amount of fat consumed to lose weight (71.7% vs 52.4%), and believe they need to lose weight (57.4% vs 28.6%) (Davy et al., 2006).

Female subjects were more likely to participate in dieting behaviors than male subjects and therefore may be more likely to also participate in other health lifestyle behavior changes. It can also be inferred that females hold stronger nutritional beliefs than males in some areas and males do not possess stronger beliefs in any area (Davy et al., 2006).

Avis, Mckinlay, and Smith (1990) also found similar results in relation to gender and nutrition behavior. As previously discussed, this study was focused on CVD knowledge of 732, 25-65 year old subjects and their health behaviors. The subjects in this study were 42.3% males and 57.7% females. A logistic regression analysis was conducted to assess the probability that respondents mentioned specific variables for preventing a heart attack or stroke. Results related to gender revealed that female subjects were significantly more likely to cut salt ($\beta=0.856$, SE= 0.260) and cut fat and cholesterol ($\beta=0.701$, SE= 0.224) from their diets than male subjects (Avis et al., 1990).

Another study examined nutrition behaviors of college students and found gender to be an impact variable (Sakamaki, Toyama, Amamoto, Liu & Shinfuku, 2005). The purpose of this study was to determine the nutritional knowledge and food habits of Chinese university students. Subjects consisted of 540 medical students between the ages
of 19 and 24 years. They were recruited from a university in Northern China (135 males and 150 females) and Southern China (95 males and 160 females) (Sakamaki et al., 2005).

All subjects completed a self-report questionnaire that was based on a national dietary survey held by the Health and Labor Ministry of Japan. The survey consisted of 21 items related to eating, drinking, and dieting habits. The parametric variables were analyzed using Student’s $t$-test, and chi-square tests were used to analyze non-parametric variables. Significance was set at $p>0.05$ (Sakamaki et al., 2005).

Eating and drinking habits were similar across subjects in eating meals regularly, where 83.6% of subjects reported eating regularly, and 79.0% reported eating meals three times per day. Gender differences were significant in several variables related to food consumption. Females were more likely than males to eat breakfast regularly (82.3% vs 66.8%), snack frequently (31.1% vs 11.5%), eat more fruits (no data shown), and when eating out, consider calories of the menu items before making a selection (data not shown) (Sakamaki et al., 2005).

In relation to dieting, 22.7% of subjects reported a history of dieting and more than 50% of subjects reported a desire to adopt healthier dietary habits. Females (29.8%) were more likely to have had a dieting experience than males (12.7%). From this study, it can be concluded that Chinese university students eat regularly and have a desire to make healthy nutrition choices. Gender does seem to play a role in the ways in which this health lifestyle is attained (Sakamaki et al., 2005).

In addition to gender being associated with nutrition behavior, literature also suggests that gender may be associated with physical activity (Howze, Smith, and
Digilio, 1989). As discussed previously, Howze, Smith, and Digilio (1989), studied the factors affecting the adoption of regular exercise by sedentary adults. The subjects participated in a ten week program, 4 hours a week (Howze et al., 1989).

The results at pre- and post-intervention revealed that high attenders to the program were more likely to be males (77%) than females (54%). Paired t-tests were conducted to compare pre- and post- intervention variables including fitness measures. The high attenders of the program experienced significant changes in fitness status. Male subjects lost, on average, 2 pounds and female subjects lost 1 pound over the 2 week intervention. High attenders, who were more often males, were able to improve their distance covered by one additional lap in twelve minutes, compared to no change in the low attenders (Howze et al., 1989).

Other health related behaviors of adolescents are also impacted by gender, including safe sex behaviors. As discussed in a previous section, Petosa and Jackson (1991) investigated the constructs of the HBM to predict students’ intentions to adopt safer sex behaviors. Subjects in the study included 679 students in grades 7, 9 and 11, between the ages of 12 and 18 years. Proportion of male and female subjects was not reported (Petosa and Jackson, 1991).

In general, the HBM constructs were strong predictors for safer sex intentions in younger adolescents, but the associations disappeared in older adolescents for all variables except gender. Gender was a significant predictor for safe sex intentions for seventh, ninth, and 11th grade students ($R^2 = 0.170; 0.106; 0.156$) (Petosa and Jackson, 1991).
Mean scores and standard deviations were also calculated for the variables of the HBM by gender and grade. Safer sex intentions in seventh graders (3.3±1.5 vs 2.7±1.6), ninth graders (3.0±1.2 vs 2.0±1.2), and 11th-graders (3.1±1.2 vs 2.0±1.4) were higher among females than males. A similar trend is also seen in AIDS/HIV knowledge which was higher among females than males in seventh (3.6±0.8 vs 3.4±0.9) and ninth grade students (3.7±0.6 vs 3.3±1.0). In all grade levels, male students had greater levels of perceived barriers than female students for seventh grade (1.8±1.3 vs 1.4±1.3), ninth grade (1.4±1.1 vs 1.1±1.0), and 11th-grade (1.2±1.2 vs 0.7±0.9) (Petosa and Jackson, 1991).

These data suggest that females are more knowledgeable regarding safe sex intentions and have higher preventive intentions (Petosa and Jackson, 1991). Females also have fewer perceived barriers, so they may be more likely to make behavior changes regarding safe sex intentions.

Sociopsychologic Aspects of College Students

College students are immersed in a single community where they live, work, and socialize for four years. During this time, the social and psychological growth is abundant. This growth is not always ideal, due to the immediate freedom and lack of guidance.

Psychological changes. In high school, most students have the comforts of a guardian that maintains their schedule, provides the essentials to live, and offers guidance. In the transition to college, students experience an increase in challenges and demands, such as a high academic demand, which can cause an increase in stress levels (Eisenberg, Gollust, Goldberstein, & Hafner, 2007; Surtees, Wainwright, & Pharoah,
2002). This increase in stress, in addition to no longer having the comforts of home to completely rely on can be a difficult situation.

Another stressor that college students face is an increased social demand. Prior to the college transition, many students have a social network with which they have grown up. In this new environment, students do not have these comforts and must establish new relationships. During this initial transition, many students have reported loneliness, homesickness, conflict, and distress in interpersonal relationships (American College Health Association, 2011; Dusselier, Dunn, Wang, Shelley, & Whalen, 2005).

In addition to stress, college aged students 18-24, tend to take more risks. According to the Willoughby, Good, Adachi, Hamsa, and Tavernier (2014), the highest level of risk taking behaviors occur in the college student population. College students participate in risky behavior such as unprotected sex, binge drinking, and illegal drug use. These behaviors put college students in unfavorable situations that can impact their health and QOL.

According to a national sample of 66,887 undergraduate respondents from 140 higher education institutions, college students reported participating in risky behaviors (American College Health Association, 2014). In relation to sexual behavior, 69.4% of undergraduate students reported having sex within the past 12 months with at least one partner and of the 69.4%, 27.9% reported at least two sexual partners within the past 12 months. Of those participating in sexual behaviors, only 55.8% used a method of contraception.

Alcohol consumption is also a common risky behavior of college students. From a nationally represented longitudinal sample of 1,000 college students, it was found that
frequency of alcohol consumption and binge drinking significantly increase during the transition from high school to college (Willoughby et al., 2014). In males, frequency of alcohol consumption increased from about two drinks per month in their final year of high school to one drink per week during the first year of college. In females, the increase in alcohol consumption from high school to college was one drink per month to three drinks per month. In relation to binge drinking, this increased from three drinks to four drinks for males and two drinks to three drinks in female college students.

According to the American College Health Association (2014), 66% of subjects reported consuming alcohol within the past 30 days. Of those that consumed alcohol, 61% reported a blood alcohol content greater than 0.08 and 69.3% reported a blood alcohol content above 0.10. Binge drinking of five or more drinks the last time the respondents partied was reported at 45.6%. In addition to alcohol consumption, 18.5% of respondents reported driving after they consumed alcohol in the past 30 days and 21.3% said they had unprotected sex following alcohol consumption (American College Health Association, 2014).

Similar trends were also seen in illegal drug use, where 19.8% of respondents reported using marijuana, and 14.4% reported using other drugs within the past 30 days. Within the past twelve months, 14.6% of subjects reported using drugs that were not prescribed to them, such as antidepressants, painkillers, sedatives, stimulants, and erectile dysfunction drugs (American College Health Association, 2014).

College students’ participation in risky behaviors can be explained by inability, or difficulty, in managing impulse control. The adolescent brain experiences many changes, some of which may be due to a lag in brain development between early maturing of the
affective system and a slower maturing of cognitive control (Steinberg, 2008). This gap in development is not filled until the mid-twenties (Ernst et al., 2006; Galvan et al., 2006). In the meantime, unfavorable behaviors resulting from lack of control may occur. Risky behaviors such as unprotected sex, alcohol consumption, and illegal drug use have been studied in relation to lack of impulse control of college students (Dunne, Freedlander, Coleman, & Katz, 2013; Lookatch, Dunne, Katz, 2012). Ultimately, college students are under a great deal of stress. This stress, a psychological variable, can have detrimental effects on overall health.

**Physiological changes.** Physiological changes that occur in college students are related to the increase in demands they face during their four years in higher education. One of the most common changes that takes place is weight gain. Several studies address this weight gain as a problem. In one study of 764 college students, weight was measured in the beginning of students’ first year of college (Racette, Deusinger, Strube, Highstein, Deusinger, 2005). By the end of their 2nd year, when measurements were repeated, a significant increase in weight by 4.1±3.6 kg was detected ($p<0.001$). Similar trends were also seen in another study of multiethnic men and women ($n=390$) from a public university in the northeastern United States (Gillen & Lefkowitz, 2011). Students reported their weight during their first semester of college. By the third semester, college students reported gaining 3.2 pounds. This weight gain did not differ by ethnic group or gender.

Although the previous studies discuss weight gain in college students within the first 2 years, other research reveals that this weight gain is consistent across all 4 years (Gropper, Simmons, Connell, and Ulrich, 2012; Racette, Deusinger, Strube, Highstein,
Deusinger, 2008). It is not common for students to lose the excess weight after their 4 years of college, and most even gain more weight. Weight gain, and behaviors that elicit weight gain, have been shown to carry into adulthood (Gordon-Larsen, Adair, Nelson, & Popkin, 2004). Being overweight or obese decreases QOL and increases the risk for developing chronic diseases such as T2D (NDS, 2014). Therefore, it is essential for college students to establish good behaviors and maintain a healthy weight.

**Chapter Summary**

Knowledge is a key construct of the HBM that impacts behavior. This is evident in health, when preventive behaviors are essential to maintain and/regain health status. More specifically, physical activity and nutrition behaviors are more prevalent in individuals that have the knowledge related to risk factors of chronic disease. Knowledge also impacts individuals’ beliefs. Perceived susceptibility, seriousness, barriers, and benefits are all intrinsic and can be swayed, either positively or negatively, to influence behaviors. Ultimately, if individuals are not aware, or lack the knowledge, of how to take preventive action or recognize that preventive action is important to maintain health, then they are less likely to participate in the health behaviors.
Chapter 3: Research Design and Methodology

Introduction

Diabetes is one of the leading causes of death in the US (Lefebvre & Pierson, 2004; NDS, 2014). In addition to premature death, diabetes can cause health complications that can interfere with QOL (Goldney, Fisher, Phillips, & Wilson, 2004; Kiadaliri, Najafi, & Mirmalwek-Sani, 2013). Diagnosis of type 2 diabetes (T2D) is associated with one or more co-existing conditions such as hypertension, obesity, cardiovascular disease, stroke, kidney disease, blindness, amputations, and depression (Goldney et al., 2004; NDS, 2014).

T2D incidence is growing in older and younger populations and thus is a public health concern (American Diabetes Statistics, 2014; Fagot-Campagna, 2000; Fagot-Campagna et al., 1999; NDS, 2014). One explanation for T2D incidence increase in all populations may be the lack of knowledge related to risk factors for T2D, such as obesity, physical inactivity, high blood pressure, abnormal cholesterol, genetics, racial/ethnic background, age, and prior gestational diabetes.

Knowler et al. (2002, 2009) and Tuso (2014) have demonstrated that T2D is preventable in individuals who are aware of the risk factors associated with the condition. Knowledge may be a critical variable in prevention of T2D.

College students make their own personal health decisions related to physical activity and nutrition, and they may not be aware of the health consequences of their behaviors. This lack of knowledge can be a predisposing factor for adverse student
behavior (Thomas, 1994). Therefore, it is essential to study the existing knowledge of college students to determine if there is a correlation between their health knowledge and health behaviors related to the prevention of T2D.

The health belief model (HBM) is used to predict health behaviors, including nutrition and physical activity (Becker et al., 1974). Knowledge is a variable in the HBM that may impact the likelihood of behavior change (Janz & Becker, 1984). Research has neglected the college student population in studying the relationship between risk factor knowledge and preventive health behaviors related to T2D. The current study will investigate knowledge of risk factors related to the individual’s perceived seriousness, susceptibility, barriers, and benefits in relation to T2D. Cues to action and self-efficacy will not be investigated because there is no evidence that they are impacted by knowledge. This chapter will discuss the sample, procedures for data collection, instruments, and the plan for data analysis.

Consistent with the HBM, this observational, quantitative study examined the relationship between the independent variable of knowledge related to the risk factors of T2D and the dependent variables of health behaviors (nutrition behaviors, or eating unhealthy, and participation in physical activity). A quantitative methodology was used for the research design. This research design was appropriate for this study because a quantitative design, rather than qualitative design, is appropriate for the scientific field of study (Atieno, 2009). As opposed to qualitative research designs that focus on exploring the process and understanding a problem, quantitative research tests objective theories and is more appropriate for observational research (Creswell, 2008). More specifically, quantitative research examines relationships among variables for significant associations.
To identify these relationships, it is essential to collect large amounts of data. A quantitative research design is an efficient way to collect and analyze a large amount of data (Creswell, 2008).

The hypotheses for this study were follows:

H 1: There is a statistically significant positive correlation between the level of diabetes knowledge and the frequency of physical activity in current college students between the ages of 18-24.

The following research questions were addressed:

1.1 Based on the Knowledge of Risks for Developing type 2 diabetes Scale and a closed-ended diabetes knowledge questionnaire, in undergraduate students between the ages of 18-24, what is the current level of knowledge related to the risk factors for and problems related to T2D?

1.2 Based on the YRBSS, what is the frequency of physical activity of current undergraduate college students, between the ages of 18-24?

1.3 Using Spearman’s rank correlation analysis, is there a significant positive correlation between level of diabetes knowledge and the frequency of physical activity in current college students between the ages of 18-24?

H 2: There is a statistically significant negative correlation between the level of diabetes knowledge and the consumption frequency of high-sugar and high-fat foods in current undergraduate college students between the ages of 18-24.

The following research questions were addressed:
2.1 Based on the Knowledge of Risks for Developing Type 2 Diabetes Scale and a closed-ended diabetes knowledge questionnaire, in undergraduate students, between the ages of 18-24, what is the current level of knowledge related to the risk factors for and problems related to T2D?

2.2 Based on the 2012 Youth Adolescent Food Frequency Questionnaire, how often is high-sugar food consumed by current undergraduate college students between the ages of 18-24?

2.3 Based on the 2012 Youth Adolescent Food Frequency Questionnaire, how often is high-fat food consumed by current undergraduate college students between the ages of 18-24?

2.4 Using Spearman’s rank correlation analysis, is there a significant negative correlation between level of diabetes knowledge and the consumption frequency of high-sugar foods by current undergraduate college students between the ages of 18-24?

2.5 Using Spearman’s rank correlation analysis, is there a significant negative correlation between level of diabetes knowledge and the consumption frequency of high-fat foods by current undergraduate college students between the ages of 18-24?

2.6 Using Spearman’s rank correlation analysis, is there a significant negative correlation between level of diabetes knowledge and the consumption frequency of high-sugar and high-fat foods, or junk foods, in current undergraduate college students between the ages of 18-24?
Research Context

The current study was conducted at a state college in Upstate New York. The university is one of 64 campuses in the State University of New York (SUNY) system. This university was an optimal location for conducting the study, because it has a large undergraduate student population (College Data, 2015). This university enrolls 8,300 students each year including 7,100 full-time undergraduates. Four thousand four hundred of these students live on campus in 13 residence halls (College Data, 2015).

Students enrolled in the university have the choice of six meal plan options that include a set number of meals per week at the dining hall that can be used for breakfast, lunch and/or dinner plus “dining dollars” to spend on additional meals or at cash dining services on campus. For example, the largest meal plan is 21 meals per week and $80.00 dining dollars per semester, while the smallest meal plan option is two meals per week with $250.00 dining dollars per semester.

Students do not have open access to a fitness center. The cost is $95.00 per academic year and $45.00 for the summer. With this membership students have open access to the two fitness centers, personal training, diet analysis, and various aerobic classes taught on campus (Institutional Research, 2015).

The university also offered a portal to administer the questionnaire anonymously to protect the identities of the subjects participating (Institutional Research, 2015). The study measured college students’ knowledge of the risk factors related to T2D and the relationships among knowledge, participation in physical activity and consumption of fats and sugars.
Research Participants

The sample for the current study was a simple random sample recruited through an email portal system from one specific campus of the State University of New York. Simple random sampling was used, because it helps limit the response bias (Fowler, 2014). Those that are more and less likely to participate in this type of research had equal opportunity to participate (Fowler, 2014). Five hundred students (n=500) out of the total full-time undergraduate population (N= 7,100) were randomly chosen to participate in this study. This sample size was chosen because the power analysis states that if there is a large effect size expected from the correlation between variables, a sample size of n=38 is necessary to detect a significant association (Cohen, 1988). Using a large sample allowed for incomplete responses to the questionnaire and the exclusion of those who did not meet the inclusion criteria (Cohen, 1988). The final sample of students who participated in the study was 51.

The inclusion criteria included both male and female full-time students between the ages of 18 and 24. Exclusion criteria include students with physical limitations, athletes, first year students, and those who have been diagnosed with diabetes. Students who have been diagnosed with a chronic condition that limits their ability to participate in physical activity and student athletes were excluded from the sample due to lack of freedom to self-determine physical activity frequency. First year students were excluded because the survey questions look at behaviors over the past year and the researcher is interested in behaviors while enrolled in college. Those previously diagnosed with diabetes were excluded because they may have more knowledge than those without the condition.
A portal was used to disseminate the introduction letter, informed consent, and questionnaire to 500 undergraduate students who had a university email. The introduction letter introduced the researcher, briefly described the purpose of the study, and discussed the role of the subject if they decided to participate (see Appendix C). If the student decided to participate, the subject was prompted to the informed consent (see Appendix D).

The informed consent offered detailed explanation of the study. It discussed the background, purpose, location, length, procedures, risks, benefits, anonymity, rights of the subject, and consent to participate. Only after the student gave electronic consent by typing “agree” into the text box, was the subject allowed to participate in the study and proceed to the questionnaire.

Anonymity of all subjects was ensured though the use of an electronic portal. The introduction letter, consent, questionnaire, and debriefing were administered through the university portal. All data were de-identified. There was no way for the university to obtain the responses to the questionnaire, and the researcher does not have access to any identifying information related to the data collected from the questionnaire.

**Instruments Used in Data Collection**

An email questionnaire was chosen to collect data, because, as opposed to an in person questionnaire or interview, it allowed convenience and complete anonymity for the subjects. This method of data collection has previously been used in other research studies to collect data related to health knowledge and behaviors of college students (Davy et al., 2006; Franko et al., 2008; Haung et al., 2003; Kim et al., 2012; Kolodinsky et al., 2007; Krešić et al., 2009; Nabhani-Zeidan et al., 2011; Sakamaki et al., 2005).
The questionnaire instrument consisted of four self-report areas: (a) demographics, (b) current knowledge of T2D risk factors, (c) physical activity behavior, and (d) dietary behavior. The demographics that were collected consisted of age, sex, race/ethnicity, academic standing, current living accommodations, mother’s education, father’s education, and history of chronic disease or illness. Self-report height and weight were also collected.

**Demographics and self-report data.** The self-reported demographic data that were collected with this questionnaire are important because in this type of research it is essential to describe the participants. Defining the population will improve precision when extrapolating it to other similar populations. It would be inappropriate to apply these results to a dissimilar population. Previous literature, regarding this type of research, has also collected and reported similar self-report data from an undergraduate student population (American College Health Association, 2011; Gillen & Lefkowitz, 2011; Krešić et al., 2009; Nabhani-Zeidan et al., 2011; Racette et al., 2008; Sallis et al., 1999). If subjects refuse to answer demographic questions, they can still continue with the questionnaire. The dropout values will be considered in the data analysis.

**T2D risk factor knowledge.** Knowledge of T2D risk factors was measured using two instruments: a closed-ended diabetes knowledge questionnaire (Simmons, Mandell, Fleming, Gatlans, & Leakehe, 1994) and the Knowledge of Risks for Developing Type 2 Diabetes Scale (Fischetti, 2009). Three measures were used to validate the instruments: Cronbach’s alpha, Kuder Richardson-20 and Spearman-Brown split half reliabilities. Cronbach’s alpha is a measure of internal consistency (Bruin, 2006). More specifically, it gauges how closely related a group of items on a survey or questionnaire are, which in
turn measures reliability. Kuder Richardson-20 (KR-20) is another measure of reliability (Zaiontz, 2016). Where Cronbach’s alpha measures multiple responses to items, KR-20 measures only binary results. An acceptable Cronbach alpha and KR-20 coefficient, would be 0.70 or higher (Bruin, 2006; Zaiontz, 2016). Another test of consistency, Spearman-Brown, is used to evaluate reliability of multi-item measures (Zaiontz, 2016). Spearman-Brown can also calculate changes in reliability of an instrument after adding new items to measure the same variable (Zaiontz, 2016).

The closed diabetes knowledge questionnaire was developed from other published diabetes knowledge questionnaires (Dunn, Bryson, Hoskins, Alford, Handelsman, & Turtle, 1984; Germer, Campbell, Smith, Sutherlans, & Jones, 1986; Karlander, Alinder, & Hellstrom, 1980; McCowen, Court, Hackett, & Parkin, 1988; Meadows, Fromson, Gillespie, & Wise, 1988). The final version of the questionnaire consisted of 31 items that stemmed from seven topics related to T2D: nature, symptoms, complications, risk factors and prevention of T2D, and identification of high fat and high sugar foods.

The questionnaire’s reliability and reproducibility were examined through a test-retest method (Simmons et al., 1994). European, Maori, and Pacific Islands subjects between 21 and 58 years participated in the study (n=350). Cronbach’s alpha produced reliability scores of 0.87 for European, 0.90 for Maori and Pacific Islands with a score of 0.89 for all groups. Pearson’s r reproducibility test identified scores of 0.69 for European, 0.38 for Maori, 0.39 for Pacific Islands and 0.50 for all subjects. All scores were significantly, positively correlated. Reproducibility was also determined with mean and range scores. The initial mean (range) score for the European subjects was 55% (0-90%) and the repeated score was 65% (0-97%). The initial mean (range) score for the
Maori subjects was 58% (0-94%) and the repeated score was 68% (0-100%). The initial mean (range) score for the Pacific Islands subjects was 48% (0-97%) and the repeated score was 55% (0-97%). The initial mean (range) score for all subjects was 52% (0-97%) and the repeated score was 61% (0-100%).

Fischetti’s Knowledge of Risks for Developing Type 2 Diabetes Scale (2009) was constructed from the Risk Perception Survey for Developing Diabetes (RPS-DD) that measured healthy adults’ perceived threat of developing diabetes (Walker, Mertz, Kalton, & Flynn, 2003). The scale also incorporates components of the HBM. Fischetti’s (2009) scale consists of 15 items related to the general risk factors for T2D. There are five possible responses that indicate how great a risk, if a risk at all, the condition or status is from “increases the risk” to “decreases the risk” of T2D.

To ensure content validity, the Knowledge of Risks for Developing Type 2 Diabetes Scale was examined by four professionals in the fields of nursing, psychology, and medicine. Following a review by the experts, four items regarding metabolic syndrome were added: “having high blood pressure,” “having high cholesterol,” “having acanthosis nigrans,” and “having polycystic ovarian syndrome” (Fischetti, 2014). These additions were made due to the central role of insulin in metabolic syndrome.

Fischetti (2009) examined the reliability of the Knowledge of Risks for Developing Type 2 Diabetes Scale through a pilot test of a convenience sample of high school students (n=202; 25 females, 177 males). Factor analysis was performed to assess the dimensionality of the 15 items on the scale. Race, endocrine abnormalities, and physiologic factors explained 59.4% of the variance. The Cronbach’s alpha reliability of the 15-item scale was satisfactory at 0.80.
In further reliability testing of this scale with an additional sample of female subjects, Fischetti (2014) evaluated 225 high school students (48 females and 177 males). KR-20 analyses were used in four-, two-, and split-half solutions. Factors were considered reliable with a HR020 solution score above 0.75. In four-factor solutions, the factor 1: black, Hispanic, and Native American was 0.75 which indicated this factor represents knowledge about ethnicity and T2D. Factor 2 was Caucasian, healthy diet, blood relative, exercise regularly, and controlling weight gain, with a KR-20 score of 0.69. When Caucasian was removed, it increased to 0.76, so Caucasian was eliminated. This score represented modifiable behavior factors and medical conditions related to diabetes.

In two-factor solutions, factor 1 consisted of Asian, Black, Hispanic, and Native American, producing a score of 0.76 (Fischetti, 2014). As in four-factor solutions, factor 1 represents knowledge about ethnicity and diabetes. Factor 2 consisted of healthy diet, blood relative, 65 years old, exercise regularly, controlling weight gain, controlling blood pressure, and fat around abdomen. It produced a KR-20 score of 0.76 representing medical conditions and modifiable behavioral factors (Fischetti, 2014).

Split-half reliability was evaluated using Spearman-Brown corrections for each factor solution. The four-factor solution produced good split-half reliabilities (factor 1: r=0.82; factor 2: r=0.78). The split-half reliabilities of the two-factor solution were also good (factor 1: 0.81; factor 2: r=0.80). Overall, the psychometric properties of the new instrument, Fischetti’s Knowledge of Risks for Developing Type 2 Diabetes Scale, are a reliable tool to assess risk factors of T2D in adolescents.
**Physical activity behavior.** The YRBSS assessed the most common behaviors of adolescents that lead to injury, disability and death (Kann et al., 2000, 2014). One of these areas is physical activity behavior. Subjects were asked two questions from the YRBSS in reference to physical activity: (a) On how many of the past 7 days have you engaged in at least 20 minutes of exercise or sport activities that resulted in sweat and heavy breathing? (b) On how many of the past 7 days have you engaged in exercises to strengthen or tone muscles? The responses for both question range from “0 Days” to “7 Days” per week. These questions have been used in previous research to measure physical activity behaviors (Huang et al., 2003). Cohen’s kappa coefficient (kappa) assessed inter-rater reliability of an instrument. A kappa score can range from 0 to 100%, where larger percentages indicate better reliability. Generally, an instrument with a kappa score range starting above 40%, and a mean above 50% is considered reliable.

Two studies have investigated the test-retest reliability of the YRBSS (Brener, Collins, Kann, Warren, &Williams, 1995; Brener et al., 2002). Brener, Collins, Kann, Warren, and Williams (1995) administered the YRBSS to a convenience sample of adolescents (n=1,679) in grades 7-12 twice, 2 weeks apart. Following analysis of the data, the questions were rated with high reliability (kappa=61%-100%). There were no statistically significant differences between the answers on the first and second administrations of the questionnaire, although those subjects in the seventh grade were least consistent. This survey is best suited for students in older grades. Reliability related to physical activity indicated ranges in kappa scores from 64.2% to 91.1% with a mean of 74.8% and a median of 72.1% (Brener et al., 1995).
Brener et al. (2002) conducted another test-retest reliability investigation on the YRBSS. The questionnaire was administered to a convenience sample of high school students \( (n=4,619) \) on two occasions, 2 weeks apart. Following data analysis, the reliability score ranged 20.6% to 90.5% with a mean of 60.7% and a median of 60.0%. The kappa scores for just physical activity ranged from 41.4% to 84.4% with a mean of 55.2% and a median of 56.2% (Brener et al., 2002).

Although an investigation of the actual validity of the YRBSS has never been conducted, Brener, Billy and Grady (2003) investigated the validity of the YRBSS through a review of literature that assesses variables that may impact the measures dating from 1980 through 2003. These variables included cognitive and situational factors that could impact the self-report data being collected through the administration of the instrument. It was concluded that although cognitive and situational factors do impact self-report data, these effects are consistent on all of the questions equally, which does not negatively impact the validity of the YRBSS. More specifically, physical activity measures were found to be influenced more by cognitive factors and less by situational factors (Brener et al., 2003). These findings relate to the current study, because the latter will be investigating the effects of knowledge, an aspect of cognition, on behavior.

**Dietary behavior.** The 2012 YAQ was used in this study to assess dietary behaviors. More specifically, two sections with questions related to *drinks* and *snack foods/desserts* were used to assess frequency of consumption of foods high in sugar and fat. All questions addressed eating behaviors over the past year and asked average consumption frequency from never to several times per day. The response choices are specific to each question.
Some studies have investigated the reliability and validity of the YAQ (Rockett & Colditz 1997; Rockett, Wolf, & Colditz, 1995). Rockett, Wolf, and Colditz (1995) investigated the reliability of the YAQ among older children and adolescents. A sample of multiethnic subjects (n=179) between the ages of 9 and 18 years old completed the YAQ twice, 1 year apart. More specifically, the intake of energy, adjusted nutrients intake, serving frequency of total energy, and intakes of protein, fat, carbohydrates, fiber, calcium, and iron were tested for reliability (Rockett et al., 1995).

Mean, median, and interquartile range were used to analyze the reliability of nutrient intakes, and paired $t$ tests were used to analyze the difference between the first time the YAQ was administered (YAQ1) and the second time the YAQ was administered (YAQ2). The mean total intake of energy significantly decreased from YAQ1 (2,477±910) to YAQ2 (2,222±841). This did not affect the reliability of the individual nutrient intakes. Each individual nutrient intake, when calculated as a percentage of total energy, remained constant from YAQ1 to YAQ2. For example, fat from YAQ1 was 28.7% and 29.5% on YAQ2 and carbohydrates were 57% on both YAQs. Overall, reliability of the YAQ for energy-adjusted nutrients ranged from 0.26 for protein and iron to 0.58 for calcium. The reliability for serving frequency ranged from 0.39 for meats to 0.57 for soda and was greater for snacks, baked goods and cereals, fruits, vegetables, milk, and soda, with correlations higher than 0.40. This study suggests that the YAQ self-administered food-frequency questionnaire is appropriate to measure eating habits in young subjects over time (Rockett et al., 1995).

The validity of the YAQ was investigated by Rockett and Colditz (1997). The YAQ was administered to a sample of subjects between the ages of 9 and 18 (n=261)
twice, one year apart (1993-1994). During this 1 year span, in-between the administration of the YAQs, three 24-hour dietary recalls were administered (first YAQ July 1993, first recall- August 1993, second recall- January 1994, third recall- June 1994, second YAQ- July 1994). Two recalls were taken on weekdays and one recall on a weekend day (Rockett and Colditz, 1997).

The validity of the YAQ was measured by comparing the pre and post YAQ and the three 24-hour dietary recalls. Pearson correlation coefficients were used to analyze the unadjusted, adjusted, and deattenuated energy intake nutrients data. For the unadjusted energy data, the coefficients ranged from 0.25 for sodium to 0.57 for folate for two YAQs and from 0.22 for sodium to 0.52 for folate for the second YAQ only. When compared to the 24-hour recalls, the YAQs mean correlation for the unadjusted nutrients was 0.41 for both YAQs and 0.39 for the second YAQ only. The mean correlation between the YAQs and the 24-hour recall for the adjusted nutrients was 0.45 for the two YAQs and 0.42 for the second YAQ only. The mean correlation between the YAQs and the 24-hour recalls for the deattenuated data was 0.54 for both YAQs and 0.50 for the second YAQ only (Rockett and Colditz, 1997).

The mean energy intake from the YAQ was higher than the 24-hour recalls but within 1%. Of the 30 nutrients investigated, six were not significantly different from the recalls. All mean nutrients, except vitamin A, carotene, and alcohol, were within 20% of each other on the YAQs and 24-hour recalls. Nineteen mean nutrients varied by less than 10% (Rockett and Colditz, 1997).

Although the questionnaires have been individually tested for reliability and validity, they have never been implemented in a study together to assess associations
between knowledge and health behaviors (Brener, Collins, Kann, Warren, & Williams, 1995; Brener et al., 2002; Fischetti, 2009, 2014; Rockett & Colditz, 1997; Rockett, Wolf, & Colditz, 1995; Simmons et al., 1994). A pre-test was conducted to assess the length of time it would take subject to complete all sections of the comprehensive questionnaire. Five undergraduate college students (2 males, 3 females; between the ages of 19 and 22) of the previously discussed university were asked to complete the questionnaire to the best of their ability. The students were from various departments including psychology, business, education, and health promotion and wellness. The time to completion for each subject consisted of 9, 11, 12, 14, and 15 minutes. Based on these response times, the questionnaire should take about 12 minutes to complete. The students did not offer any input related to the content of the questionnaire. A final, comprehensive version of the questionnaire can be viewed in Appendix E.

**Procedures for Data Collection and Analysis**

The data were collected electronically and coded by the researcher. As a result of the coding, each subject was given knowledge, physical activity, sugar, fat, and total junk food score. The knowledge score was out of a possible 46 total points. The closed-ended diabetes knowledge questionnaire (Simmons et al., 1994) which had multiple correct answers for each question, allowed for a maximum score of 31 points where subjects received one point for each correct response (selecting the correct response or leaving out the incorrect response). The Knowledge of Risks for Developing Type 2 Diabetes Scale (Fischetti, 2009) allowed for a maximum score of 15, where the subject got one point for choosing each correct response. For incorrect responses in each questionnaire, 0 points were given. Therefore, the total maximum knowledge score a subject could obtain was
46. Higher scores indicated that subjects had greater knowledge of T2D risk factors, while lower scores indicated lower knowledge of T2D risk factors (Fischetti, 2009).

Physical activity was scored out of 14 points. Subject’s scores for cardiovascular and resistance activity were averaged to give a mean physical activity score. A score of 14 points would represent a subject who has engaged in a minimum of 20 minutes of cardiovascular and resistance training physical activity every day for the past 7 days, while a score of 0 represents a subject who had not participated in any physical activity over the previous week.

Sugar and fat intake frequencies were assessed on a scale from 0-3 based on the daily recommended intakes. A score of 0 identified a subject who did not, or very rarely, consumed the particular food. A score of 1 identified a subject who typically ate the food more than never but less than once per week. A score of 2 identified a subject who consumed the food more than once per week but less than once per day. A score of 3 identified a subject who consumed the food more than once per day. Overall, subjects could obtain a total sugar score from 0-117, a total fat score from 0-9, and a combination junk food consumption score from 0-26 (sugar + fat = junk food)

The World Health Organization (2015) strongly recommended that sugar intake be less than 10% of total recommended calories for adults 19 years and older. Additionally the World Health Organization (2015) has discussed a conditional recommendation that states sugar intake should be reduced to less than 5% of total recommended calories for adults each day. Although a conditional recommendation requires much debate in regards to policy, there are still factors associated with this
reduced intake that would presume it to be more beneficial for the subject in relation to health and preventing obesity.

An example of coding a question related to sugar intake from the YRBSS is as follows:

Over the past year how often did you drink not-diet soda/pop (1 can or individual bottle)?

1. Never/less than 1 per month (score=0)
2. 1-3 bottles per month (score=1)
3. 1 bottle per week (score =2)
4. 2-4 bottles per week (score=2)
5. 5-6 bottles per week (score=2)
6. 1 bottle per day (score=3)
7. 2 bottles per day (score=3)
8. 3 or more bottles per day (score=3)

Dietary recommendations for fat intake were also considered in the coding strategies. The U.S. Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (USDHHS) (2010) recommended less than 10% of total caloric intake be from saturated fatty acids. Saturated fatty acids make up the fat in many snack foods that the YRBSS evaluates, and reducing intake can also reduce risk of chronic disease (USDA, 2010). An example of coding a question related to fat intake from the YRBSS is as follows:

Over the past year how often did you eat potato chips (1 small bag)?

1. Never/less than 1 per month (score=0)
2. 1-3 small bags per month (score=1)
3. One small bag per week (score=2)

4. 2-6 small bags per week (score=2)

5. 1 or more small bags per day (score=3)

Alcohol consumption was coded similarly to sugar intake and was added to that score. The USDA and USDHHS (2010) quantify moderate consumption of alcohol for females to be one drink and for males two drinks per day. A drink is considered 12 fluid ounces of 5% beer, 5 ounces of wine, and 1.5 fluid ounces of 80 proof liquor. Each of these contains 6/10 of an ounce of alcohol. Heavy drinking was considered consuming more than three drinks per day or more than seven per week for females and more than four drinks per day or more than fourteen drinks per week for males (USDA, 2010).

Over the past year how often did you drink beer (1 glass, bottle, or can)?

1. Never/ less than 1 per month (score=0)

2. 1-3 cans per month (score=1)

3. 1 can per week (score=2)

4. 2-4 cans per week (score=2)

5. 5-6 cans per week (score=2)

6. 1 can per day (score=3)

7. 2 cans per day(score=3)

8. 3 or more cans per day (score=3)

SPSS statistical software 22.0 (IBM Corp., Armonk, NY., USA) was used to conduct descriptive analysis of the demographic data in the form of means, medians, standard deviations, minimums, maximums, and frequencies. The demographic data included age, sex, height, weight, BMI, family history of T2D, T2D knowledge, sugar
consumption frequency, fat consumption frequency, and junk food consumption frequency.

Kolmogorov-Smirnov tests were used to assess normality of the distribution of the data. Based on this distribution test such as correlations, chi-square, and Mann-Whitney $U$ were conducted.

Inferential analyses, Spearman’s rank correlations, were used to test for relationships between knowledge of T2D risk factors and frequency of physical activity and food consumption behaviors, because the data were non-normally distributed. The data were displayed in tables and discussed in narrative formats.

Further analyses, beyond the research questions and hypotheses, were also conducted to assess the other constructs of the HBM. Perceived susceptibility was assessed using Spearman’s rank correlation analysis to see if there was any association between BMI and T2D knowledge, frequency of physical activity, sugar consumption frequency, fat consumption frequency, and junk food consumption frequency. Mann-Whitney $U$ tests also tested perceived susceptibility to see if there was a relationship between family history of T2D and BMI, T2D knowledge, physical activity, sugar consumption, fat consumption, and junk food consumption.

Finally, Mann-Whitney $U$ tests were also used to evaluate the sex differences in the sample. More specifically, the Mann Whitney $U$ tests were used to determine sex differences in BMI, T2D knowledge, physical activity, sugar consumption, fat consumption, and junk food consumption.
Chapter Summary

This chapter discussed the context, subject characteristics, instruments, and analyses that will be used to assess the relationship between college students knowledge of risk factors related to T2D and their health behaviors. Subjects were sampled from a state university in upstate New York. The participants consisted of male and female undergraduate college students between the ages of 18 and 24 who attended the university. To assess knowledge, physical activity behavior, and food consumption, three questionnaires were administered electronically through the university portal. The data were analyzed to assess frequencies of demographic data and correlations between level of knowledge, physical activity, and consumption of high-fat and high-sugar foods.

The research was approved by SUNY Oswego’s Institutional Review Board (see Appendix F) and by St. John Fisher’s Institutional Review Board. The researcher disseminated the questionnaires to the population through the portal via email at the start of the semester and at two, four, and six week increments from the initial distribution date. Reminder emails were distributed to all emails that did not responded prior to sending the email. The goal was to obtain a majority of responses before mid-semester. The entire sample was not collected; thus an additional reminder email was sent. The portal was closed to responses a month later and the researcher began analyzing the data.
Chapter 4: Results

Introduction

This chapter examines the association between college students’ knowledge of the risk factors for and problems related to T2D, and student behaviors related to physical activity and diet. First, the hypotheses and research questions will be stated. Then the data analysis procedures will be discussed, including distribution of data, and specific statistical software and tests that were used to analyze the data. The characteristics of the subjects will be discussed in detail and the findings related to the research hypotheses and research questions will be stated. Finally, additional analyses will be conducted to further investigate the data.

Hypotheses and Research Questions

The hypotheses for this study were as follows:

H 1: There is a statistically significant positive correlation between the level of diabetes knowledge and the frequency of physical activity in current college students between the ages of 18-24.

The following research questions were addressed:

1.1 Based on the Knowledge of Risks for Developing Type 2 Diabetes Scale and a closed-ended diabetes knowledge questionnaire, in undergraduate students between the ages of 18-24, what is the current level of knowledge related to the risk factors for and problems related to T2D?
1.2 Based on the YRBSS, what is the frequency of physical activity of current undergraduate college students, between the ages of 18-24?

1.3 Using Spearman’s rank correlation analysis, is there a significant positive correlation between level of diabetes knowledge and the frequency of physical activity in current college students between the ages of 18-24?

H 2: There is a statistically significant negative correlation between the level of diabetes knowledge and the consumption frequency of high-sugar and high-fat foods in current undergraduate college students between the ages of 18-24.

The following research questions were addressed:

2.1 Based on the Knowledge of Risks for Developing Type 2 Diabetes Scale and a closed-ended diabetes knowledge questionnaire, in undergraduate students, between the ages of 18-24, what is the current level of knowledge related to the risk factors for and problems related to T2D?

2.2 Based on the 2012 Youth Adolescent Food Frequency Questionnaire, how often is high-sugar food consumed by current undergraduate college students between the ages of 18-24?

2.3 Based on the 2012 Youth Adolescent Food Frequency Questionnaire, how often is high-fat food consumed by current undergraduate college students between the ages of 18-24?

2.4 Using Spearman’s rank correlation analysis, is there a significant negative correlation between level of diabetes knowledge and the
consumption frequency of high-sugar foods by current undergraduate college students between the ages of 18-24?

2.5 Using Spearman’s rank correlation analysis, is there a significant negative correlation between level of diabetes knowledge and the consumption frequency of high-fat foods by current undergraduate college students between the ages of 18-24?

2.6 Using Spearman’s rank correlation analysis, is there a significant negative correlation between level of diabetes knowledge and the consumption frequency of high-sugar and high-fat foods, or junk foods, in current undergraduate college students between the ages of 18-24?

In addition to the correlations that were conducted to test these hypotheses, chi-square, and Mann-Whitney U tests were used to further explore the data based on the emerging results.

**Detailed description of data collection.** Using Enterprise Surveys through Blackboard, questionnaires were administered to a simple random sample of 500 students at one specific campus of the State University of New York college system. The questionnaire was sent through student emails by an instructional designer at the university four times throughout the semester, every 2.5 weeks. The Blackboard portal to complete the questionnaire remained open for an additional month for students to complete the questionnaire.

Of the 500 questionnaires distributed, data were collected from 54 subjects, and 51 subjects met the eligibility criteria; three subjects were excluded because they exceeded the 18-24 year old age range. The information from the questionnaire was sent
electronically to the researcher through the use of the portal without any identifying information, such as name or email. The researcher compiled the data for analysis using a password secure computer.

The variables of interest in this study were knowledge of T2D risk factors for and problems related to T2D (T2D knowledge), frequency of physical activity, sugar consumption frequency, fat consumption frequency, and junk food consumption frequency. Junk food encompasses foods high in fat and/or sugar. To further investigate the variables, sugar consumption was broken down into the variables sugar-sweetened beverages, and sugar-sweetened foods. Sugar sweetened foods were broken down into foods that were high in carbohydrates (high carb sugars) and foods that were high in fats (high fat sugars). Demographic variables included sex, age, height, weight, family history of T2D, mother’s education, father’s education, living accommodations, and past injury and illness.

Body mass index (BMI) was calculated from subjects’ height and weight using the following equation: BMI = weight (kg) / height * height (m^2). BMI is commonly used to evaluate body composition and has been shown to be correlated with more direct measures of body composition assessment such as skinfold thickness and bioelectrical impedance analysis (Freedman, Horlick, & Berenson, 2013; Garrow & Webster, 1985). The values obtained from the BMI measures classify individuals as underweight (<18.5), healthy weight (18.5 to 24.9), overweight (25.0 to 29.9), and obese (≥30); these categories have been shown to be strong predictors of metabolic diseases (Centers for Disease Control, 2015; Freedman et al., 2013).
**Distribution of data.** According to the Kolmogorov-Smirnov tests for normality, the majority of the data were not normally distributed. Of the twelve variables tested, only three were normally distributed: weight ($D=0.123; p=0.051$), BMI ($D=0.118; p=0.071$), and junk food consumption ($D=0.122; p=0.054$). Since most variables were non-normal and the distributions of these variables were borderline normal, the researcher used non-parametric testing for all variables.

**Data Analysis and Findings**

The statistical software used to analyze the data was SPSS 22.0 (IBM Corp., Armonk, NY., USA). The findings from the data were discussed based on descriptive statistics, correlations, chi-square, and Mann-Whitney $U$ tests.

**Descriptive statistics.** Means, medians, standard deviations, minima, and maxima were used to describe data for age, height, weight, BMI, family history of T2D, T2D knowledge, physical activity, sugar consumption frequency, fat consumption frequency, and junk food consumption frequency for the entire sample (Table 4.1). In addition, frequency was used to describe sex, BMI, family history of T2D, T2D knowledge, physical activity, sugar consumption frequency, fat consumption frequency, and junk food consumption frequency (Table 4.1).
Table 4.1

Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age_yrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>20.6</td>
<td>21.0</td>
<td>1.0</td>
<td>19.00</td>
<td>23.00</td>
</tr>
<tr>
<td>Female</td>
<td>39</td>
<td>20.5</td>
<td>20.0</td>
<td>1.0</td>
<td>19.00</td>
<td>23.00</td>
</tr>
<tr>
<td>Male</td>
<td>12</td>
<td>20.6</td>
<td>20.8</td>
<td>1.1</td>
<td>19.00</td>
<td>23.00</td>
</tr>
<tr>
<td>Height_m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>1.68</td>
<td>1.65</td>
<td>0.11</td>
<td>1.47</td>
<td>1.93</td>
</tr>
<tr>
<td>Female</td>
<td>39</td>
<td>1.63</td>
<td>1.63</td>
<td>0.07</td>
<td>1.47</td>
<td>1.78</td>
</tr>
<tr>
<td>Male</td>
<td>12</td>
<td>1.83</td>
<td>1.83</td>
<td>0.08</td>
<td>1.68</td>
<td>1.93</td>
</tr>
<tr>
<td>Weight_kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>77.2</td>
<td>74.8</td>
<td>20.4</td>
<td>49.90</td>
<td>136.08</td>
</tr>
<tr>
<td>Female</td>
<td>39</td>
<td>75.1</td>
<td>68.0</td>
<td>19.4</td>
<td>50.80</td>
<td>113.40</td>
</tr>
<tr>
<td>Male</td>
<td>12</td>
<td>83.8</td>
<td>81.7</td>
<td>23.2</td>
<td>49.90</td>
<td>136.08</td>
</tr>
<tr>
<td>BMI_kg/m²</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>27.3</td>
<td>25.8</td>
<td>6.33</td>
<td>13.75</td>
<td>41.71</td>
</tr>
<tr>
<td>Female</td>
<td>39</td>
<td>29.0</td>
<td>26.5</td>
<td>6.20</td>
<td>19.01</td>
<td>41.71</td>
</tr>
<tr>
<td>Male</td>
<td>12</td>
<td>32.2</td>
<td>32.5</td>
<td>5.0</td>
<td>20.00</td>
<td>40.00</td>
</tr>
<tr>
<td>T2D Knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>33.8</td>
<td>34.0</td>
<td>3.9</td>
<td>20.00</td>
<td>45.00</td>
</tr>
<tr>
<td>Female</td>
<td>39</td>
<td>34.2</td>
<td>34.0</td>
<td>3.4</td>
<td>27.00</td>
<td>45.00</td>
</tr>
<tr>
<td>Male</td>
<td>12</td>
<td>32.2</td>
<td>32.5</td>
<td>5.0</td>
<td>20.00</td>
<td>40.00</td>
</tr>
<tr>
<td>Physical Activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>3.5</td>
<td>3.0</td>
<td>3.3</td>
<td>0.00</td>
<td>12.00</td>
</tr>
<tr>
<td>Female</td>
<td>39</td>
<td>3.3</td>
<td>2.0</td>
<td>3.3</td>
<td>0.00</td>
<td>12.00</td>
</tr>
<tr>
<td>Male</td>
<td>12</td>
<td>3.8</td>
<td>4.0</td>
<td>3.2</td>
<td>0.00</td>
<td>12.00</td>
</tr>
<tr>
<td>Sugar</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>25.2</td>
<td>24.0</td>
<td>8.8</td>
<td>10.00</td>
<td>49.00</td>
</tr>
<tr>
<td>Female</td>
<td>39</td>
<td>25.2</td>
<td>23.0</td>
<td>8.6</td>
<td>10.00</td>
<td>47.00</td>
</tr>
<tr>
<td>Male</td>
<td>12</td>
<td>25.3</td>
<td>25.0</td>
<td>9.8</td>
<td>12.00</td>
<td>49.00</td>
</tr>
<tr>
<td>Fat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>3.6</td>
<td>4.0</td>
<td>1.8</td>
<td>0.00</td>
<td>6.00</td>
</tr>
<tr>
<td>Female</td>
<td>39</td>
<td>3.3</td>
<td>3.0</td>
<td>1.7</td>
<td>0.00</td>
<td>6.00</td>
</tr>
<tr>
<td>Male</td>
<td>12</td>
<td>4.5</td>
<td>4.5</td>
<td>1.6</td>
<td>1.00</td>
<td>6.00</td>
</tr>
<tr>
<td>Junk Food</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>28.8</td>
<td>28.0</td>
<td>9.1</td>
<td>12.00</td>
<td>54.00</td>
</tr>
<tr>
<td>Female</td>
<td>39</td>
<td>28.5</td>
<td>27.0</td>
<td>8.8</td>
<td>12.00</td>
<td>48.00</td>
</tr>
<tr>
<td>Male</td>
<td>12</td>
<td>29.8</td>
<td>29.0</td>
<td>10.3</td>
<td>18.00</td>
<td>54.00</td>
</tr>
</tbody>
</table>
The final sample consisted of 51 subjects (39 females; 12 males). The mean age of included subjects was 20.6 years (SD±1.0), and mean age was similar between males (mean=20.6; SD±1.1) and females (mean= 20.5; SD±1.0). Eighty-six percent of the sample was Caucasian (Caucasian n=44; African American n=4; mixed race n=2; and unknown n=1) and 90% were non-Hispanic (Hispanic n=5; non-Hispanic n=46). These proportions are broadly representative of the total student population for this campus in fall 2015. Caucasians are slightly over-represented (86% currently surveyed; 75.2% overall) (Institutional Research, 2015). Of the total sample, 33.4% reported having an immediate family member diagnosed with T2D. Sixty-one percent of the total sample reported living off campus, while 39% reported living on campus, which is not representative of the total undergraduate population where 40% live off campus and 60% live on campus. A possible explanation for the inflated number of students in the total sample, not reflecting the total population, living off campus may be due to the exclusion of the freshmen population who are required to live on campus their first year, whereas upper classmen may have a tendency to move off campus when eligible.

Subjects were asked to self-report their height and weight. From these values, BMI was calculated. The average height of the total sample was 1.68 meters (SD±1.11). On average, males (1.83 m; SD±0.08) were taller than females (1.63 m; SD±0.07). The average height for 20-29 year olds, according to 2007-2010 reference data from the U.S. Department of Health and Human Service (DHHS) (2012), for males was 1.76 m (SE±0.003) and was 1.63m (SE±0.002) for females. In relation to height, the female subjects in this study were representative of the U.S. population, while the male subjects were slightly taller than the U.S. population average (DHHS, 2012).
The average BMI of subjects was 27.3 kg/m² (SD±6.33) which, according to the Centers for Disease Control and Prevention (2015), falls into the classification of overweight (both sexes 25.0-29.9 kg/m²). Although, on average, both males and females fell into the overweight classification, average BMI was lower in males (25.2 kg/m²; SD± 6.52) than females (29.0 kg/m²; SD± 6.20). Of the total sample, 41% were of healthy BMI, 22% were classified as overweight, 33% were classified as obese, and 4% were underweight. The average BMI for 20-29 year olds, according to 2009-2010 reference data from the US DHHS (2012), for males was 26.8 kg/m² (SE±0.24) and was 27.5 kg/m² (SE±0.42) for females. Thus the mean BMI for the male sample for this study was slightly lower than the U.S. population age-specific average, and the mean BMI for our female subjects was slightly higher than the U.S. population age-specific average (CDC, 2015).

Family history of diabetes was also assessed. A majority of subjects reported having knowledge that someone in their immediate family (mother, father, brother, sister, or grandparent) was diagnosed with diabetes (62.7%). Three percent were unsure if anyone in their immediate family was diagnosed with diabetes, and 33.3% stated that no one in their immediate family was diagnosed with diabetes. Of those who were aware of a family history, 47.1% reported their family member being diagnosed with T2D (31.4% of total sample). Fifteen subjects (44.1%) reported having a family member diagnosed with diabetes, but not knowing if the diagnosis was T1D or T2D. Three subjects (8.8%) identified their immediate family member being diagnosed with T1D.

Parent level of education is the highest level of education attained by the subject’s mother or father. Parent level of education was scored as a 0 if the parent did not go to
high school, 1 if they had some high school, 2 if they graduated high school or received a general education degree (GED), 3 if they participated in some college or technical school, 4 if they obtained a 4 year degree, and 5 if they attended graduate school or had professional training. In previous research, these categories correlated positively with SES such that higher levels of parent education were associated with higher SES (Gillen & Lefkowitz, 2011; Laiho et al., 1991). A chi-square test was run to assess if there was an association between mother and father education level. Results indicated that there was a strong likelihood of association between mothers’ and fathers’ level of education ($x^2(20) = 74.866; p=0.000$).

Frequency data were also used to describe the distribution of the parent education and family history of T2D data. The average education of both mothers and fathers was participation in some college or technical school (31.4% mothers, n=16; 37.3% fathers, n=19). A total of 14 mothers and 10 fathers from the sample had less than a college or technical school education (includes parents who did not attend high school, had some high school, graduated from high school or received a GED, participated in some college or technical school, but did not obtain a 4-year degree: 27.5% mothers; 19.6% fathers) which would classify them as lower SES. Seventy-one percent of mothers and 80% of fathers had a minimum of a college education (includes parents who obtained a 4-year degree or beyond), which could classify them as higher SES. On average, the subjects were of families that could be classified as high SES.

Subjects also reported history of disease and injury. Twenty percent of the sample reported being affected by a chronic disease or illness. These subjects reported being affected by asthma, endometriosis, high blood pressure, rheumatoid arthritis, acid
reflux, hay fever, chronic back issues, anxiety, tumor, and migraines. When reporting injury over the past year, 17.6% of the sample reported having an injury. Reported injuries include knee surgery, plantar fasciitis, sprained ankle, and broken hand.

**Research questions 1.1 and 1.2.** T2D knowledge, a structural variable from the HBM, was scored from 0-46, such that, a higher score reflected a greater knowledge of the risk factors for and problems related to T2D. The average T2D knowledge score was 33.8 for the total sample (SD±3.9). This was slightly higher for females (34.2; SD±3.4) than for males (32.2; SD±5.0).

Physical activity was scored from 0-14, such that higher scores indicated participation in more frequent bouts of ≥20 minute sessions of physical activities per week. The maximum reported number of ≥20 minute sessions of either resistance or cardiovascular physical activity was 14 (total ≥280 minutes). On average, subjects reported participating in 3.5 sessions (SD±3.3) of physical activity per week (total ≥70 minutes). This was slightly higher for males (3.8 sessions per week; SD±3.2) than for females (3.3 sessions per week; SD±3.3).

**Research questions 2.1 through 2.3.** As previously mentioned, subjects had a mean score of 33.8 (SD±3.9) for T2D knowledge. Sugar consumption frequency was scored from 0-117, with higher scores indicating more frequent consumption of high-sugar foods. On average, subjects’ sugar consumption frequency score was 25.2 (SD±8.8) and was similar for females and males (females 25.2, SD±8.6; males 25.3, SD±9.8).

Fat consumption was scored from 0-9, and higher scores indicated more frequent consumption of high fat foods. The mean fat consumption frequency score for the sample
was 3.6 (SD±1.8). This score was higher for males (4.5; SD±1.6) than females (3.3; SD±1.7). Junk food consumption, a sum of high sugar food and high fat food consumption frequencies, was scored from 0-126. The average junk food consumption frequency for the sample was 28.8 (SD±9.1). Due to the high fat food consumption frequency in males, this score was higher in males (29.8; SD±10.3) than females (28.5; SD±8.8).

**Correlations.** Spearman’s rank correlation analyses were used to indicate correlations between T2D knowledge and the dependent variables. Spearman’s rank correlation analysis was used because the majority of the data were non-normally distributed and/or ordinal (based on a ranking system, rather than continuous data) (Table 4.2).

Table 4.2

*Spearman’s Rank Correlations for T2D Knowledge*

<table>
<thead>
<tr>
<th></th>
<th>n = 51</th>
<th>rho</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight_kg</td>
<td>0.128</td>
<td>0.370</td>
<td></td>
</tr>
<tr>
<td>BMI_ kg/m²</td>
<td>0.215</td>
<td>0.129</td>
<td></td>
</tr>
<tr>
<td>Physical Activity Sessions/Week</td>
<td>0.157</td>
<td>0.272</td>
<td></td>
</tr>
<tr>
<td>Sugary Food Consumption Frequency</td>
<td>0.215</td>
<td>0.130</td>
<td></td>
</tr>
<tr>
<td>Fatty Food Consumption Frequency</td>
<td>-0.038</td>
<td>0.790</td>
<td></td>
</tr>
<tr>
<td>Junk Food Consumption Frequency</td>
<td>0.194</td>
<td>0.173</td>
<td></td>
</tr>
</tbody>
</table>
Research questions 1.3 and 2.4 through 2.6. The association between T2D knowledge and frequency of physical activity was assessed. Based on the findings, it can be concluded that T2D knowledge is not a significant predictor of the frequencies of physical activity, sugar consumption, fat consumption, or junk food consumption. Therefore, the researcher failed to accept H1 and H2.

It was unexpected to see such a weak correlation between T2D knowledge and sugar consumption frequency, so sugar consumption frequency was broken down into sugar-sweetened beverages and sugar-sweetened foods. Sugar-sweetened foods were then broken down into high carbohydrate sugars and high fat sugars. Spearman’s rank correlation analyses were used to assess the association between T2D knowledge and these modified sugar consumption frequency variables. Findings suggested that T2D knowledge was positively significantly correlated with sugar sweetened food consumption frequency (\(\rho=0.283; p=0.045\)) and, more specifically, consumption frequency of high carbohydrate sugars (\(\rho=0.282; p=0.045\)). T2D knowledge was not significantly correlated with consumption frequency of sugar-sweetened beverages (\(\rho=-0.027; p=0.852\)) or consumption frequency of high fat sugars (\(\rho=0.225; p=0.113\)). These results further counter H2, because they indicate that as T2D knowledge increases, so does the consumption frequency of overall high sugar foods and high carbohydrate sugars. Therefore, the researcher failed to accept H2.

BMI and T2D family history (perceived susceptibility). Further analyses were conducted to investigate possible reasons why eating habits were not influenced by T2D knowledge. One area of interest was BMI. BMI is a variable that is representative of the perceived susceptibility construct of the HBM. Previous research has shown that BMI is
significantly positively correlated with perceived susceptibility to T2D (Amuta, Barry, & McKyer, 2015) which, according to the HBM, may impact health behaviors. For example, subjects may not be concerned with participating in physical activity and their eating behaviors if they were of healthy BMI, or had a low perceived susceptibility to T2D. Spearman’s rank correlation was used to evaluate correlations between T2D knowledge and the dependent variable, because the data were nonparametric and ordinal: a rank system (Table 4.3).

Table 4.3

*Spearman’s Rank Correlations for BMI*

<table>
<thead>
<tr>
<th></th>
<th>n=51</th>
<th>rho</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2D Knowledge</td>
<td>0.215</td>
<td>0.129</td>
<td></td>
</tr>
<tr>
<td>Physical Activity Sessions/Week</td>
<td>0.226</td>
<td>0.111</td>
<td></td>
</tr>
<tr>
<td>Sugary Food Consumption Frequency</td>
<td>-0.151</td>
<td>0.289</td>
<td></td>
</tr>
<tr>
<td>Fatty Food Consumption Frequency</td>
<td>-0.186</td>
<td>0.191</td>
<td></td>
</tr>
<tr>
<td>Junk Food Consumption Frequency</td>
<td>-0.151</td>
<td>0.290</td>
<td></td>
</tr>
</tbody>
</table>

The results suggest that there was no significant association between BMI and T2D knowledge, frequency of physical activity, sugar consumption frequency, fat consumption frequency, or junk food consumption frequency (Table 4.3). There were trends for an association between high BMI and high frequency of physical activity, low
sugar consumption frequency, low cat consumption frequency, and low junk food consumption frequency.

Subjects were asked to report on their family history of T2D. This was used as an indirect measure to assess perceived susceptibility, a construct of the HBM. Previous research shows that when subjects have an immediate family member with T2D they see the effects first-hand and believe they may too be at risk (Amuta et al., 2015; Claassen et al., 2010). Having the knowledge of the risk for developing T2D may increase their likelihood to participate in preventative behaviors in hopes of preventing the onset of the disease.

A Mann-Whitney $U$ test was run to determine if there was a significant relationship between subjects with a known family history of T2D and BMI, T2D knowledge, frequency of physical activity, sugar consumption frequency, fat consumption frequency, and junk food consumption frequency. Subjects with a family history of T2D did have a higher BMI ($p=0.108$) but it was not significant. No other differences were detected based on family history of T2D.

**Sex-related differences.** The data suggested a clear sampling bias by sex. Seventy six point five percent of the subjects were female and 23.5% of the subjects were male (females tripled male response rate). Therefore, Mann-Whitney $U$ tests were conducted to see if there were any additional sex-related differences between BMI, T2D knowledge, frequency of physical activity, sugar consumption frequency, fat consumption frequency, and junk food consumption frequency. The Mann-Whitney $U$ test was used because the dependent variables were nonparametric and continuous. The results from this analysis revealed that males are significantly taller than females.
(\(p<0.001\)) and their frequency of fat consumption was significantly higher than for females (\(p=0.043\)). Sex-related differences between BMI, weight, frequency of physical activity, sugar consumption frequency, junk food consumption frequency, and T2D knowledge were not significant.

**Summary of Results**

In summary, based on the results of the current study, we have failed to accept both H1 and H2. Knowledge of the risk factors for and problems related to T2D is not significantly associated with T2D preventive behaviors, such as frequency of physical activity and the frequency of the consumption of high fat and high sugar foods. However, although there may not be significant correlations among the previously mentioned variables, this may be due to the limited sample size that will be discussed in the next chapter. Also, in the following chapter, effect sizes for associations will be discussed. Effect size will reinforce the limitation of sample size in this study. Additionally, the next chapter will discuss future research ideas and recommendations for colleges and universities to implement more opportunities for healthy behavior choices.
Chapter 5: Discussion

Introduction

The purpose of this study was to investigate the impact knowledge has on behaviors. More specifically, this study examined the relationship between college students’ knowledge of the risk factors and problems related to T2D and health behaviors. The health behaviors investigated were those that would reduce their risk for developing T2D, such as frequency of physical activity and consumption of high sugar and high fat foods. This study was a pilot study to evaluate the questionnaire for data collection, the variables of interest (knowledge, frequency of physical activity, sugary and fatty food consumption frequency), and sample size, for future research. This chapter presents the implications of the findings related to the hypotheses and research questions, states any limitations, and provides recommendations based on the findings.

Implications of the Findings

Since this was a pilot study, findings from this study will contribute to scholarly understanding and have implications that will impact the college student population, parents, and policy makers within colleges. In addition to the direct implications for higher education, the findings from this study informs decision making and/or policy in public secondary school education. In public secondary school education, there may be an influence on health and physical education guidelines in which policy makers will recognize the need to set a more appropriate knowledge base for healthy behaviors.
**Theory.** The HBM encompasses several constructs that impact health behavior change including modifying variables, individual perceptions, and barriers versus benefits (Janz & Becker, 1984 & Rosenstock, 1974). The modifying factors that were investigated in this study include demographic and structural variables. The demographic variables were age, sex, race, ethnicity, SES, and living accommodations. The structural variable was knowledge of T2D risk factors and problems related to T2D. Sociopsychologic variables were not discussed as part of this study.

**Structural variable.** The structural variable, knowledge, was the key variable in this study. The researcher investigated the impact that knowledge of T2D risk factors, and problems related to T2D, had on college student health behaviors, such as physical activity and eating habits. It was hypothesized that greater levels of subject T2D knowledge will be associated with more frequent bouts of physical activity. It was also hypothesized that greater T2D knowledge would be associated with less frequent consumption of high fat and high sugar foods.

As illustrated in the results, this study fails to support both main hypotheses (H1 and H2). In the college student population, these analyses fail to detect a statistically significant association between T2D knowledge and positive health behaviors (frequent physical activity participation and/or low junk food consumption frequency). Therefore, effect size was evaluated as an indicator of the meaningfulness of the associations among the variables. A meaningful association would be an association between knowledge and physical activity participation and/or consumption frequency of junk food in a moderate epidemiological sample size (e.g. 1,000). Evidence of a meaningful association between knowledge and frequency of physical activity participation and/or consumption
frequency of junk food will provide a basis for designing a future study with this precise methodology. It is essential to use the same methodology, including research tools and a comparable sample composition, because modifications would change likely change the effect sizes of detected associations.

Effect size. Cohen (1988) stated that, in the behavioral sciences, effect size can be used for power calculations to determine required sample size for future research. The guidelines that Cohen (1988) states are as follows: a small effect size would be present with an $r=0.10$; a medium effect size with $r=0.30$; and a large effect size with $r=0.50$. These values are specific to the Pearson’s $r$ correlation between two quantitative variables and help to further interpret and discuss statistical hypothesis testing and sample size planning. Pearson’s $r$ and Spearman’s rank correlation can range between -1 and 1, with -1 indicating a perfect negative linear correlation, 1 indicating a perfectly positive linear correlation, and 0 indicating no linear relationship between the two variables (Cohen, 1988).

In the current study the relationship between the variables of H1, T2D knowledge and frequency of physical activity, are not statistically significant at the 0.05 alpha level. However, according to Cohen (1988), the results of the Spearman’s rank correlation analysis for H1 indicate that the association represents a small effect, approaching a medium effect size between T2D knowledge and frequency of bouts of physical activity ($\rho=0.157$). This particular small to medium effect size for the association between T2D knowledge and frequency of bouts of physical activity suggests that with a sample size of 430, we would expect to detect a significant association between T2D knowledge and frequency of physical activity. A small to medium effect, on the broader population of
18-24 year olds in the US, for the association between T2D knowledge and frequency of bouts of physical activity may still have an important influence. If 18-24 year olds in the US (total in 2010 30,672,088; Howden & Meyer, 2011) have a higher level of knowledge regarding T2D, they may be more likely to participate in behaviors that minimize their risk for developing T2D, such as frequent physical activity.

In relation to the data for H2, there is not a significant association between T2D knowledge and the consumption frequency of high-sugar, high-fat and junk foods. However, according to Cohen (1988), the results of the Spearman’s rank correlation for H2 indicated trends toward an association represented by small to medium effects between T2D knowledge and sugar consumption frequency (rho=0.215) and junk food consumption frequency (rho=0.194). These effect sizes suggest that with a sample size of 225 for T2D knowledge and sugar consumption frequency, and 279 for T2D knowledge and junk food consumption frequency, we would expect to detect a significant association. Therefore, a small to medium effect, on the broader population of 18-24 year olds in the US, for the association between knowledge related to T2D and sugar consumption frequency may still have an important influence. If 18-24 year olds in the US have a higher level of knowledge regarding T2D, they may be more likely to consume high sugar foods more frequently.

The small to medium effects are not apparent for T2D and fat consumption (rho=-0.038) and a sample size of 7,486 would be required to detect a significant association. The negligible effect is so small that it is not likely to be meaningful. It is so small it explains hardly any variance and the researcher would need a much larger sample to detect significance between T2D knowledge and fat consumption frequency than T2D
knowledge and sugar and junk food consumption frequency. However, unlike the relationship between T2D knowledge and frequency of sugar and junk food consumption, which has a small to medium positive effect, T2D knowledge and fat consumption frequency, is inversely related. This more closely aligns with H2, where the researcher expected to see a decrease in consumption frequency of high fat and high sugar foods with more T2D knowledge. Still, according to Cohen (1988) the effect size for the association between T2D knowledge and consumption frequency of fat does not have even a small effect. Since fat consumption is a component of junk food consumption, we can assume that T2D knowledge may be more closely associated with just sugar consumption rather than sugar and junk food consumption frequency.

**Perceived susceptibility.** Individual perceptions, such as perceived susceptibility to T2D, were also considered as constructs of the HBM that may impact health behaviors such as frequency of physical activity and consumption frequency of high sugar and high fat foods. The HBM indicates that higher perceived susceptibility to disease, such as T2D, increases the perceived threat of the disease which increases their likelihood to make health behavior changes to minimize their risk of disease (Rosenstock, 1974). The individual perceptions that are being investigated in this study are BMI and family history of T2D.

**BMI.** BMI was investigated as an indicator of perceived susceptibility because previous research of college students (n=319) showed that BMI is significantly positively correlated with higher perceived risk for developing T2D ($p<0.01$) (Amuta et al., 2015). Past qualitative research of college students (n=45) also indicated that when someone does not feel they are at risk for developing a disease/illness, they are less likely to take
preventative action against that disease/illness (Das & Evans, 2014). In the case of healthy subjects who do not view themselves at risk because they were of healthy BMI, then they would be less likely to participate in physical activity or eat healthy due to lack of perceived susceptibility. In those subjects with healthy BMIs, knowledge would not have as great of an impact on behavior change because the subjects do not feel they are at risk; they have a low perceived susceptibility. The lack of perceived susceptibility would be less likely to be influenced by knowledge, because the subjects with a healthy BMI do not believe they have a low perceived threat of disease.

In the current study, 41% of subjects are of healthy BMI, 22% are overweight, 33% are obese, and 4% fall below the recommended BMI guidelines (were defined as underweight) (CDC, 2015). Therefore, the population of interest for perceived susceptibility is the 55% of subjects who are not of healthy BMI and are either overweight (22%) or obese (33%), because these subjects should have a high perceived susceptibility due to their risk of T2D related to BMI.

Previous research that assessed T2D risk perceptions of overweight and obese college-aged students (n=319), found that subjects with higher BMIs had a higher perceived risk for developing T2D ($\beta=0.315; p<0.01$) (Amuta et al., 2015). According to the HBM, when individuals possess a characteristic that increases their perceived susceptibility to disease, such as being overweight or obese, their likelihood of taking preventative action against disease increases, because they have a high perceived threat for developing the disease. In the current study, where 55% of the subjects fall into the CDC’s (2015) classification at-risk classification for being overweight or obese, we would expect subjects to have a high perceived susceptibility to T2D. This high
susceptibility would likely be impacted by T2D knowledge. Without T2D knowledge they may not be aware that being overweight or obese is a risk factor for T2D, and therefore would be less likely to participate in preventative behaviors to reduce risk.

Overall, a higher perceived susceptibility to T2D would lead us to expect subjects to participate in more frequent bouts of physical activity and consume high sugar and high fat foods less frequently in expectation of reducing T2D risk. However, in the current study, the research does not detect a significant association between T2D knowledge and BMI or BMI and preventative behaviors such as participation in physical activity and less frequent consumption of high sugar and high fat foods. The lack of association between BMI and frequency of participation in positive health behaviors could be due to the instrument used to assess physical activity and dietary behavior, which will be discussed in the limitations.

Family history of T2D. Family history of T2D was also investigated as the perceived threat construct of the HBM. Research suggested that when overweight and obese college-aged students (n=319) had a family member with T2D, they had a significantly higher perceived threat for developing T2D ($\beta=0.147, p<0.02$) (Amuta et al., 2015). Another study by Harwell et al., (2001) assessed the risk perceptions of T2D in adults 45 years and older (n=576). Of this sample, n=217 reported a family history of T2D. The probability of considering oneself at risk for T2D was higher in those subjects with a family history of T2D (n=92; 42%) than those who did not have a family history of T2D (n=37; 10%). The higher perceived threat in subjects with family members diagnosed with T2D may be due to the hereditary nature of T2D and seeing firsthand the complications that are associated with the disease. The hereditary component of T2D
puts direct relatives of those with the diagnosis at greater perceived threat than if they didn’t have a family member with T2D. Interactions between the diagnosed family member and the subject allow them to see the complications associated with T2D more than a subject without a diagnosed family member (Amuta et al., 2015). This is only the case if the T2D is not well managed. If the T2D family member manages T2D well, then it will not cause alarm to the subject.

T2D knowledge must be considered in combination with T2D family history. Subjects must have the knowledge that there is a hereditary component associated with T2D. They must also have the knowledge that will empower them to improve their behavior. Without knowledge of the family history component, they may not be aware of their risk of T2D which would result in a low perceived susceptibility to T2D. With a low perceived susceptibility, resulting from lack of knowledge of the influence of family history on disease risk; even knowing that they have a family history of T2D, their likelihood of participation in physical activity and eating foods high in sugar and fat would be less likely to occur.

Of the total sample from the current study, 31% to 60% of subjects have an immediate family member diagnosed with T2D. Therefore, we can expect that subjects were familiar with T2D, because they had a family member diagnosed with T2D, which we would expect to increase their perceived susceptibility to T2D. Even with a high susceptibility there is no indication that the at-risk subjects in the current study are participating in health behaviors such as frequent physical activity and/or consuming high sugar and high fat foods less frequently. The lack of association between T2D family history and frequency of positive health behaviors could be due to the weakness of the
data on family history; some subjects were unaware of their family history. This is a clear lack of self-knowledge on the part of the subjects. Additionally, the lack of association could be due to the weakness of the instrument used to assess physical activity and dietary behavior, which will be discussed in the limitations.

However, findings from this study indicate a strong trend towards group difference in BMI when T2D family history is considered. Subjects with a family history of T2D are more likely have a higher BMI, and thus be classified as overweight, but this association is not significant ($p=0.108$). In a larger sample, significant group differences for BMI may be able to be detected.

Overall, the researcher does not detect significant associations among perceived susceptibility, BMI, or family history of T2D, and health behavior frequencies (physical activity, consumption frequency of high fat and high sugar foods). One explanation for a lack of association between perceived susceptibility and positive health behaviors may be the instrument used to assess perceived susceptibility. It was assessed indirectly and incompletely through BMI and family history of T2D. Another explanation for lack of association between perceived susceptibility and positive health behaviors may be the failure to assess perceived seriousness. According to the HBM, perceived seriousness, in combination with perceived susceptibility, impacts perceived threat to influence behavior change. Limitations, indirect measurements and missing measurements, will be discussed later in this chapter.

**Barriers versus benefits.** There are many studies related to the barriers and benefits of making a behavior change to limit the risk of T2D (Greaney et al., 2009; Kim et al., 2012; Tuomilehto et al., 2001). The present study addresses the barriers subjects
face regarding frequency of health behaviors such as frequency of physical activity and consumption frequency of high sugar and high fat foods. Barriers are the obstacles that must overcome to make a successful behavior change and can include cost, pain, side-effects, time commitment, etc. (Janz & Becker, 1984). Similar to perceived susceptibility, barriers are perceptions as well. They can be anything that would hinder the subject from participating in the desired health behavior.

The barriers noted in the current study are SES and living accommodations. SES is considered a barrier because research shows that low SES is associated with poor health behaviors such as physical inactivity and poor nutrition (Pampel, Krieger & Denney, 2010). Pampel et al. (2010) stated that “health behaviors account for, on average, roughly one-quarter of SES disparities in health” (p.3). If subjects in the current study are of low SES, the literature would support that the low SES subjects were already at a disadvantage for participating in positive health behaviors and less likely to participate in physical activity and more likely to consume high sugar and high fat foods frequently. Habitually, low SES subjects would already be more prone to poor lifestyle choices and thus continue with these behaviors. In this study, two-thirds of the parents have a minimum of a college education (includes parents who obtained a four year degree or beyond), which classifies them as moderate to high SES. Since a majority of the subjects fall into the higher SES category, low SES is not likely a barrier for a majority of these subjects and not likely to influence poor health behaviors. Therefore, the research cannot conclude that the lack of association between T2D knowledge and positive health behaviors may be due to the barrier of SES.
Living accommodations, such as subjects living on campus or off campus, were also evaluated as a barrier to making a behavior change to limit risk of T2D due to food availability. Living on campus, students have access to the dining hall for their meals. Dining halls offer many food options to students. The choices that are made can be healthy, high in essential nutrients, or unhealthy, high in sugar and fat. Either way, both food options, healthy and unhealthy, are equally accessible to the student living on campus. Subjects living off campus do not have the same convenient access to the range of food options, particularly healthy food options, as those living on campus and eating in the dining halls. Students living off campus must make the conscious decision and commitment to purchase and prepare healthy foods on their own. Purchasing and preparing food can be time consuming and expensive. Previous research stated that college students find it difficult to make health eating choices due to lack of time (Das & Evans, 2014). The lack of time, and the unavailability of healthy foods to students living off campus may make choosing unhealthy food options, such as fast-foods a more convenient option; thus, lack of time and availability are barriers to participating in healthy behaviors (Greaney et al., 2009). Subjects who live off campus may be more likely to choose unhealthy food options, foods high in sugar and fat, due to time and convenience. Similar to low SES subjects, living off campus puts subjects at a disadvantage for participating in positive health behaviors such as avoiding consuming high sugar and high fat foods frequently.

In the current study, 61% of the final sample report living off campus, while 39% report living on campus. A majority of subjects living off campus could explain the lack of association between T2D knowledge and consumption frequency of high sugar and
high fat foods. Subjects living off campus may experience barriers such as limited availability to healthy food options, and thus consumed more high sugar and high fat foods, which are more accessible.

Benefits are not addressed in this study because research shows that, in the HBM, the knowledge variable impacts confidence, which in turn impacts benefits (Kim et al., 2012). In a study of college students (n=251) benefits were significantly correlated with behaviors of physical activity ($r=0.28, p<0.001$) and eating healthy ($r=0.15, p<0.05$) (Kim et al., 2012). Therefore, if subjects had a higher knowledge, they would also perceive the benefit as greater. Greater perceived benefits increase the likelihood of participating in healthy behaviors such as physical activity and consuming high sugar and high fat foods less frequently.

The current study focused on T2D knowledge as an indicator of benefits. The researcher assumed that subjects with a higher T2D knowledge will understand the benefits of making a behavior change, such as improved disease risk and maintain QOL. If the subject had a greater level of perceived benefits, they would be more likely to participate in behaviors that will benefit them such as physical activity and avoiding consumption of high sugar and high fat foods.

**Limitations**

As a pilot project for future research, there are a few limitations that should be acknowledged including: (a) limited sample size, (b) weaknesses of the preexisting validated questionnaire to measure physical activity, (c) failure to thoroughly assess consumption frequency of foods high in fat, (d) failure to assess all constructs of the HBM directly, and (e) reliance on self-report data.
The first significant limitation is the low response rate. As previously mentioned, Cohen’s (1988) research implies that with a larger sample size, we would be more likely to detect significant associations in the data between knowledge and behavior. Also, related to the sample composition, 76.5% of subjects are females that chose to participate in the research. A female sample of 76.5% of the population is not representative of the true campus population which has 51.3% females (College Data, 2015). In future studies efforts should be made to assure that the response population be representative of the context in which the study is made.

The data collection tools for this study are a combination of four validated questionnaires. Two of these questionnaires were constructed to measure knowledge, one to assess frequency of physical activity, and another to assess consumption frequency of high sugar and high fat foods. The greatest area of concern with this questionnaire is the failure to truly quantify physical activity. The questionnaire asks subjects “On how many of the past 7 days have you engaged in at least 20 minutes of exercise or sport activities that resulted in sweat and heavy breathing?” and “On how many of the past 7 days have you engaged in exercises to strengthen or tone muscles?” The options for responses for both questions range from “0 Days” to “7 Days” per week. Due to the restricted nature of this question, only allowing subjects to report 20 minute bouts of exercise, is not a true assessment of total physical activity for the week. For example, subjects could have participated in five, 60 minute bouts of physical activity during the week, but because the question only asks about 20 minute bouts their total physical activity would only be considered as 100 minutes rather than 300 minutes. In addition to failing to quantify physical activity, this questionnaire does not discuss the type of
activity beyond cardiovascular and resistance training. The question related to
cardiovascular exercise asks to report only when the subjects have experienced heavy
breathing and sweat. Depending on the subject, activity, and length of engagement in the
physical activity this could be a 20 minute walk or a 60 minute run. The differences
between a 20 minute walk and a 60 minute run should be considered when assessing
physical activity to quantify a true measure of frequency of physical activity. Future
research should have a questionnaire that allows subjects to fully communicate their
physical activity, such as a self-report physical activity journal that not only discusses the
type of exercise, but the length and intensity.

Although not as great of a concern as physical activity assessment, another
limitation associated with the questionnaire is the assessment of dietary behavior. The
questionnaire assesses consumption frequency of high fat and high sugar foods and
drinks. Of the total food consumption frequency questions asked, 39 were related to
sugar consumption and three were related to fat consumption. Those questions related to
fat consumption assess how often the subject ate fried food and potato chips. The
questions do not address the type of fat being consumed. For example, there is no way to
decipher from these questions in what oil the food is fried. If subjects eat potato chips
that are homemade and fried in olive oil and/or baked, they are consuming less bad fat
than if they are eating store bought potato chips. The questionnaire also fails to ask about
other foods that are high in fat, such as fast foods. Regularly eating fast food is a
concern, especially in the US due to its association with health problems, such as T2D.
Future research should include more specific questions related to fat consumption to
better assess fat consumption frequency.
Another limitation of the study is not addressing all constructs of the HBM. The HBM is made up of eight concepts, six of which impact perceived threat of disease to increase the likelihood of participating in healthy behaviors (demographics, sociopsychologic variables, knowledge, perceived susceptibility, perceived seriousness, and cues to action), and two of which directly impact increased the likelihood of participating in healthy behaviors (barriers minus benefits). The only variables of the HBM that are directly measured in this study are: the demographic variables (age, sex, weight, BMI, SES, living accommodations, race, and ethnicity), knowledge, and the frequency of participation in health behaviors (physical activity and high sugar and high fat consumption). As previously discussed, perceived susceptibility to T2D was measured indirectly though BMI and family history of T2D. Barriers to participating in behaviors to prevent T2D were measured indirectly though SES and living accommodations. Failure to address the additional constructs reduces the completeness of the set of influential independent variables. Thus, other variables involved in determining frequency of physical activity, sugar consumption, and fat consumption have not been taken into account. For example, perceived seriousness of disease is another perception construct of the HBM that increases perceived threat. In this study, if the researcher assessed this variable (as a function of knowledge) in combination with perceived susceptibility, as the model suggests, there may have been a stronger association between T2D knowledge (via perceived susceptibility and seriousness) and frequency of physical activity, sugar consumption, and fat consumption.

Additionally, there are constructs that were assessed indirectly; perceived susceptibility to T2D and barriers to participating in behaviors to prevent T2D. Through
the indirect measurement of the constructs, the researcher is making assumptions of the variables relationship. For example, BMI is an indicator of perceived susceptibility of T2D because previous research made this association (Amuta et al., 2015). However, the current study did not evaluate the association between BMI and susceptibility; it just assumed an association. In future research it may be beneficial to measure perceived susceptibility with questions that clearly ask the subject if they think they are susceptible to T2D. Furthermore, in future research we can also ask the subjects to what degree they believe they are at risk for T2D and why or why not they believe they are at risk. This would eliminate the problematic assumptions and possibly show a stronger association between perceived susceptibility, which is impacted by T2D knowledge, and frequency of physical activity, sugar consumption, and fat consumption.

Another assumption related to perceived susceptibility is the exposure between the T2D family member and subject. It is assumed that: (1) there is contact between the subject and the family member, and (2) the diagnosed family member has complications associated with the disease. If the subject had limited to no interaction with the family member diagnosed with T2D, then the subject will have a low perceived susceptibility. Alternatively, if the subject has regular contact with the family member diagnosed with T2D, there is a higher likelihood of perceived susceptibility. This likelihood is even greater if the family member that is diagnosed with T2D does not manage their T2D well, and has progressed to stages where complications associated with T2D are apparent. The subject is seeing firsthand the complications of the disease which increases their perceived susceptibility. If the family member is managing their T2D well and has not developed complications associated with T2D, the perceived susceptibility may not have
as great of an effect on the subject. If the perceptions are low then, according to the HBM, there is lower likelihood that subjects will participate in the positive health behaviors.

A final limitation is the self-report data. There is no way to tell if the information provided by the subjects is accurate or biased. Subjects may have completed the survey without reading the questions just to get to the T2D information at the end. In research that requires self-report data, we have to assume that enough of the information provided is accurate to a degree in which running analyses will overcome inaccuracies.

**Recommendations**

Future studies of college students’ behavior should focus on perceptions. Previous research has shown that college students are optimists in regard to high risk behaviors (Amuta et al., 2015; Copeland, Kulesza, Patterson, & Terlecki, 2009; Schwartz et al., 2010). College students do not anticipate the impact that their behaviors will have on their future health. Therefore, even though college students may have the knowledge regarding the consequences and how to make the behavior change, they will not make the change because they do not perceive a risk (Amuta et al., 2015; Downing-Matibag & Geisinger, 2009). Future research should investigate these optimist perceptions. What is it about this population that makes them feel indestructible?

Additionally, the perceptions of subjects in this study, related to perceived susceptibility, were fairly low. This was reflected in their health behaviors of low frequency of physical activity and frequent consumption of high sugar and high fat foods. Therefore in future research we may consider investigating other constructs of the HBM that may impact behavior change, such as perceived seriousness. Perceived seriousness,
in combination with perceived susceptibility, impacts perceived threat of disease. When both perceived seriousness and perceived susceptibility are high, the subject has a great perceived threat of disease and is more likely to participate in positive health behaviors to prevent the disease. For example, in the current study, subjects that had a family history of T2D may have a high susceptibility, but if the family member was managing the T2D well, the subject may not believe the complications associated with T2D were serious enough to take preventative action. Therefore, the subjects would be less likely to participate in physical activity and more likely to consume high sugar and high fat foods frequently. In future research, it would be beneficial to investigate both perceived susceptibility and perceived seriousness more directly, because both constructs impact perceived threat of disease.

College students’ lack of anticipated risk perceptions may put them at a disadvantage in the future, because the behaviors in which they participate now will affect them into their adult lives. For example, not participating in physical activity and frequently consuming foods high in sugar and fat will not only be behaviors that they are more likely to continue with post-college, but the effects of these behaviors such as obesity, will need to be controlled in future. It is imperative for colleges and universities to address this concern so they can provide the best services to their students.

Colleges and universities are distinctive, such that they have access to a population in which they can manipulate health barriers. Health behaviors that can be altered include availability of healthy food choices and physical activity opportunities. Healthy food choices should dominate over unhealthy food choices in the dining halls and other dining locations on campus. Physical activity opportunities should include the
availability of a free fitness center, funding for club sports, and informative seminars or courses that promote physical activity.

Based on the results of this study, the majority of the college student population is overweight, and in many cases obese. It is imperative for higher education institutions to understand the implications of excess weight on health problems and implement programs to help combat the effects. For example, colleges can require students to take a class that focuses on health management, more specifically, weight management. Although students may not feel they are at risk, they will at least be given the tools to help manage weight gain in their future lives.

Higher education institutions should also consider promoting healthier lifestyles for their students by offering more opportunities for physical activity, good nutrition, and health education/support groups. This can be accomplished through a free gym membership, more club sports, and more healthy food options in the dining halls and food service locations on campus. Each of these recommendations will improve the lifestyles of college students by offering an opportunity to make a healthy behavior change, or continue with their current healthy lifestyle.

Additionally, research shows that healthy bodies have a direct significant correlation to a healthy mind. In a meta-analysis (Sibley & Etnier, 2003) researchers found that physical activity improved cognitive skills, such as perceptual skills, intelligence quotient, achievement, verbal tests, mathematic tests, developmental level/academic readiness during childhood and young adulthood (effect size=0.25; SD=0.27). Nutrition has also been shown to impact cognitive function. The consumption of a healthy diet, rich in vitamins, folate, and omega-3 fatty acids was
associated with more favorable cognition and brain health in healthy older adults (n=293; Bowman et al., 2012). Alternatively, diets high in fat and sugar have been shown to negatively impact memory in healthy children and young adults (Francis & Stevenson, 2011; Micha, Rogers, & Nelson, 2011; Nabb & Benton, 2006). Therefore it is essential to create a healthy environment within institutions that strive for academic excellence. Colleges and universities should develop opportunities to help facilitate healthy behaviors.

Conclusion

Diabetes is one of the leading causes of death in the US and it is spreading worldwide (Lefebvre & Pierson, 2004; NDS, 2014). More specifically, T2D is a concern because of its association with premature death and coexisting complications such as amputation, blindness, hypertension, and cardiovascular disease (Goldney et al., 2004; NDS, 2014). Although once considered an adult onset disease, an increase in incidence rates have been detected in children and adolescents, which predisposes these younger populations to the coexisting conditions (NDS, 2014). It is essential to investigate what is causing these poor health behaviors, which lead to T2D, in young populations.

The HBM has been used to examine and predict health behaviors in various populations. The HBM is based on perceptions, demographics, and knowledge related to the disease. Each of these components impact perceived threat of the disease, which increases the likelihood of the subject to make the behavior change. This study focuses on college students’ knowledge of the risk factors and problems associated with T2D and if knowledge impacts health behaviors. In reference to this study, desired health
behaviors include frequent participation in physical activity and less frequent consumption of high fat and high sugar foods.

The HBM focuses on prevention as a means to maintain and regain health status. Therefore, the HBM suggests that the greater knowledge is of risk factors related to chronic disease, the more likely one is to participate in positive health behaviors in hope of prevention. Previous research has investigated the variable of knowledge in relation to preventive behavior and chronic disease (Jayanti & Burns, 2009; LeClair et al., 2009, 2010; Petosa and Jackson, 1991). In younger populations, that have no known risk of T2D, other researchers have detected trends between lack of knowledge and poor health behaviors (LeClair et al., 2009, 2010). Therefore, it would be beneficial to the knowledge base to investigate other youthful population to see if those that have a higher level of knowledge participate in positive health behaviors.

T2D can be prevented with positive health behaviors (Knowler et al., 2002, 2009). A gap in the literature exists in identifying the association between knowledge of the risk factors associated with T2D and the desired health behaviors. Therefore, this study examines the relationship between college students’ knowledge of T2D (risk factors and associated problems) and students’ health behaviors.

This research increases the knowledge base for the design of future studies regarding what predicts health behaviors of college students. This type of research is important, because a better understanding of what motivates behavior will help policy makers at colleges and universities to plan and implement programs to improve knowledge and health behavior.
The current study was conducted at a state college in Upstate New York. The university is one of 64 campuses in the SUNY system and enrolls 8,300 students each year including 7,100 full-time undergraduates. Four thousand four hundred of these students live on campus in 13 residence halls (College Data, 2015).

The sample for the current study was a simple random sample recruited through an email portal system from one specific campus of the State University of New York (n=500). The final sample obtained was n=51. All subjects were male and female, undergraduate students between the ages of 18 and 24 attending the university. Subjects who have been diagnosed with a chronic condition that limits their ability to participate in physical activity and student athletes were excluded from the sample due to the varying degree in which they could participate in physical activity. Also, subjects that were eligible for the study must have been living on campus or away from home a minimum of 1 year. Therefore, all first year students were eliminated.

The questionnaire instrument consisted of four self-report areas: (a) demographics, (b) current knowledge of T2D risk factors, (c) physical activity behavior, and (d) dietary behavior. The demographics that were collected consisted of age, sex, race/ethnicity, academic standing, current living accommodations, mother’s education, father’s education, and history of chronic disease or illness. Self-report height and weight were also collected. Knowledge of T2D risk factors were measured using two instruments: a closed-ended diabetes knowledge questionnaire (Simmons, Mandell, Fleming, Gatlans, & Leakehe, 1994) and the Knowledge of Risks for Developing Type 2 Diabetes Scale (Fischetti, 2009). Subjects were asked two questions from the YRBSS to assess frequency of physical activity and question from two sections of the 2012 YAQ to
assess dietary behaviors. More specifically, two sections in the YAQ were related to drinks and snack foods/desserts to assess consumption of foods high in sugar and fat.

SPSS 22.0 (IBM Corp., Armonk, NY., USA) was the statistical software used to analyze the data and the statistical tests used to analyze the data were based on descriptive statistics, correlations, chi-square, and Mann-Whitney U test.

The major findings are related to the research questions of this study. The average T2D knowledge score was 33.7 out of 46 for the total sample. Subjects reported participating in an average of 3.5 out of 14 sessions (SD±3.35) of physical activity per week (70 minutes). On average, subjects’ sugar consumption frequency score was 25.2 out of 117, the mean fat consumption for the sample was 3.6 out of 9, and the mean junk food consumption for the sample was 28.8 out of 126.

In relation to the hypotheses, the researcher failed to accept the hypotheses; H1 and H2. The researcher did not detect a significant correlation between T2D knowledge and health behaviors within this sample population. However, the individual constructs of the HBM that were expected to be related to T2D knowledge, physical activity and frequency of fat and sugar consumption, were further investigated to identify why we failed to detect significant associations between T2D knowledge and health behaviors.

In the current study the relationship between the variables of H1, although not statistically significant at the 0.05 alpha level, did indicated that the association represents a small effect, approaching a medium effect size between T2D knowledge and frequency of physical activity (rho=0.157) (Cohen, 1988). This suggests that with a sample size of 430, we would expect to detect a significant association between T2D knowledge and frequency of physical activity.
In reference to H2, the researcher did not detect a significant association. However, the data indicated trends toward an association between T2D knowledge and sugar consumption frequency \((\rho=0.215)\), and junk food consumption frequency \((\rho=0.194)\), represented by a small to medium effect (Cohen, 1988). These trends suggest that with a sample size of 225 for sugar consumption frequency and 279 for junk food consumption frequency, we would expect to detect a significant association. These effects were not apparent for T2D and fat consumption \((\rho=-0.038)\) and a sample size of 7,486 would be required to detect a significant association.

Additionally, perceived susceptibility, seriousness, benefits, and barriers were discussed as influencing constructs for behavior change, possible limitations, and possible topics for future research.
References


Center for Disease Control and Prevention (2015). Division of nutrition, physical activity and obesity. Atlanta, GA: USA.


Appendix A

Health Belief Model

**MOTHER'S PSYCHOLOGICAL LEVEL OF READINESS TO TAKE RECOMMENDED HEALTH ACTION**

- **Motivations (Predispositions)**
  - a. Physical threat
  - b. Control over health matters
  - c. Attitude toward medical authority
  - d. General health concern

- **Value of Threat Reduction**
  - a. Child's vulnerability
  - b. Degree of bodily harm
  - c. Interference with social roles

- **Probability of Action Reducing the Threat**
  - a. Belief in diagnosis
  - b. Perceived efficacy of the medicine
  - c. Belief in modern medicine

**MODIFYING FACTORS**

- **General**
  - a. Demographic variables
  - b. Family problems
  - c. Structure of medical care (continuity); satisfaction with clinic; learning new behavior; physician-patient communication
  - Specific to Present Illness
    - a. Family experience
    - b. Child's prior experience with that illness (and that medicine)

**COMPLIANCE**

- **Readiness to Take Recommended Health Action**

- **Cues to Action**
  - a. Child's symptomatology
  - b. Advice from others
  - c. Medicine
  - d. Follow-up appointment

* "Motivations" refers to differential emotional arousal in individuals caused by some given class of stimuli (e.g., health matters).

**figure 2** Reformulated "Health Belief Model" as predictor of compliance in pediatric situations.
Appendix B

Expanded Health Belief Model

FIGURE 2
The Expanded Health Belief Model
Appendix C

Letter of Introduction to the Participants

Dear Student:

Thank you for taking the time to consider participating in this investigation. I am a candidate in St. John Fisher’s doctoral program in Executive leadership. I have a background in health promotion, science education, and physiology. My research interest is in students’ knowledge of Type 2 Diabetes.

The purpose of this project is to better understand college your knowledge of the risk factors of Type 2 Diabetes risk. Your participation in this study will entail a 15 minute questionnaire.

All study procedure have been approved by the Institutional Review Boards at St. John Fisher College and SUNY Oswego.

Again, thank you for taking the time to consider participating in this study.

Elizabeth Keida
SJFC Ed.D Candidate Executive Leadership
Assistant Professor
Department of Health Promotion and Wellness
SUNY Oswego
105E Park Hall
Oswego, NY 13126
elizabeth.benevento@oswego.edu
Appendix D

Consent/Authorization Form

Title of Study:
Knowledge of risk factors related to Type 2 Diabetes.

Researcher:
Elizabeth Keida, M.S.
Dr. C. Michael Robinson

Contact Information:
crobinson@sjfc.edu (Dr. C. Michael Robinson)

Background/Purpose of Study:
The study in which you are about to participate investigates your knowledge of the risk factors of Type 2 Diabetes risk. The questionnaire also includes questions about your background, eating habits, and exercise habits. Elizabeth Keida, M.S., professor in the Department of Health Promotion and Wellness at SUNY Oswego, is leading the study. The study has been approved by the Human Subjects Committee at SUNY Oswego.

Place/Length of Study:
SUNY Oswego/ 15 minute survey

Study Procedures:
If you consent to participate in this study you will be prompted to complete a questionnaire. This questionnaire consists of four individual sections, and it should take you about 20 minutes to finish. These sections include: (1) background, (2) diabetes knowledge, (3) exercise behavior, and (4) eating behavior.

Risks & Benefits:
This research should not cause you any risk or discomfort. There is also minimal psychological, social, political, legal, and economic risk. You may experience a slight inconvenience having to complete the 15 minutes survey.

This study will investigate your current knowledge of type 2 diabetes risk factors. Regardless of your knowledge level, upon completion of the questionnaire, you will be given access to a website to improve your knowledge related to the risk factors for type 2 diabetes.
**Method for Protecting Confidentiality/Privacy:**
This is an electronic survey. Each person’s data in this study will be anonymous. At no time will the researcher be in contact with the subjects or have any identifying information. The email distribution will be arranged through the instructional design department at SUNY Oswego to ensure subject anonymity. Anonymity of all subjects will be ensured though the use of an electronic portal. The introduction letter, consent, questionnaire, and debriefing will all be administer through the university portal. There will be no way for the university to attain the responses to the questionnaire and the researcher will not have access to any identifying information related to the data collected from the questionnaire.

Your name will not be reported and the data that will be reported will be the average for all participants. Following completion of the research the de-identified data will be secured in a password protected document on the researcher’s computer. This data will be kept for three years for auditing purposed and then destroyed.

**Voluntary Participation/Study Withdrawal:**
Each person’s data in this study will be confidential. The researcher will have no way of matching your name to the questionnaire you will complete. Your name will not be reported, and the data that will be reported will be averaged across participants. By participating in this study, you will increase your understanding of psychological research. At the end of the study, a full explanation of the study will be given to you. During this time you will also be given the opportunity to increase your knowledge regarding type 2 diabetes.

Your participation is voluntary, and you are free to discontinue participation at any time without penalty.

**Your Rights as a Research Participant:**
You have the right to:
1. Have the purpose of the study, and the expected risks and benefits fully explained to you before you choose to participate.
2. Withdraw from participation at any time without penalty.
3. Refuse to answer a particular question without penalty.
4. Be informed of appropriate alternative procedures or courses of treatment, if any, that might be advantageous to you.
5. Be informed of the results of the study.

I have read the above, received a copy of this form, and I agree to participate in the above-named study.

**Consent to Participate In Research & Authorization to Use and Share Information:**
I have read the above statement about the purpose and nature of the study, and I freely consent to participate.
I hereby give my consent to participate in this research study and agree that my personal
information can be collected, used and shared by the researcher and staff for the research
study described in this form. I will be able to print a copy of this consent form.

_________________________________________  ____________________________
Type name (participant)               Check here to indicate signature Date

_________________________________________  ____________________________
Type name (investigator)             Signature                                      Date

If you have any further questions regarding this study, please contact the researcher listed
above.

If you experience emotional or physical discomfort due to participation in this study,
please contact the SUNY Oswego’s of Academic Affairs at 315-312-2290 or the Health
& Wellness Center at 315-312-4100 for appropriate referrals.

The Institutional Review Board (IRB) of St. John Fisher College has reviewed this
project. For any concerns regarding confidentiality, please call Jill Rathbun 585-385-
8012. She will direct your call to a member of the IRB at St. John Fisher College.
Appendix E

Questionnaire

Please complete the questionnaire to the best of your ability/knowledge:

I. Demographics:

1. Date of Birth (mm/dd/yyyy) ____________
2. Gender:
   a. Male
   b. Female
3. Race
   a. Asian American
   b. American Indian/Alaskan Native
   c. Black/ African American
   d. Native Hawaiian or other Pacific Islander
   e. White/ Caucasian
   f. Mixed race
   g. Unknown
   If mixed race please state____________
4. Ethnicity
   a. Hispanic
   b. Non-Hispanic
5. Height: ___feet___ inches
6. Weight: _______pounds
7. Academic standing:
   a. This is my first semester on a college campus/enrolled in college.
   b. This is my second semester on a college campus/enrolled in college.
   c. This is my second year on a college campus/ enrolled in college.
   d. This is my third year on a college campus/ enrolled in college.
   e. I have been on a college campus for 4 or more years/ enrolled in college.
8. Are you a student athlete
   a. Yes, for a University team (NCAA)
   b. Yes, for a competitive club sport (non-NCAA)
   c. Yes, for a recreation club sport (non-NCAA)
   d. No
9. Which of the following best describes your current living accommodations?
   a. On campus in a residence hall
   b. Off campus in a house/apartment, not living with parents/guardians
   c. Off campus in a house/apartment, living with parents/guardians

10. Are you currently affected by any chronic (long term, more than one year) disease/or injury (e.g. knee surgery, broken bones, etc.)?
   a. Yes
   b. No
   If yes, state disease(s)_________________

11. Have you recently been involved in an injury that has precluded you from physical activity during the past year (knee surgery, broken bones, etc.)?
   a. Yes
   b. No
   If yes, state injury(s)_________________

12. What is your mother’s highest level of education completed
   a. Didn’t go to high school
   b. Some high school
   c. High school graduate or GED
   d. Some college or technical school
   e. 4 year college graduate
   f. Graduate school or Professional Training
   g. I Don’t know

13. What is your father’s highest level of education completed
   a. Didn’t go to high school
   b. Some high school
   c. High school graduate or GED
   d. Some college or technical school
   e. 4 year college graduate
   f. Graduate school or Professional Training
   g. I don’t know

14. Does anyone in your family (parents, grandparents, siblings) have Diabetes?
   a. Yes
   b. No
   c. I don’t know

15. If yes, do you know if it is Type 1 or Type 2 Diabetes?
   a. Type 1 Diabetes
   b. Type 2 Diabetes
   c. I don’t know
   d. No one in my family has Diabetes
II. Type 2 Diabetes

Circle all answers that apply to the question asked. Note: questions may have more than one correct response. **Choose all that apply.**

1. Which of these is/are true?
   a. A person with type 2 diabetes will have it for the rest of his/her life.
   b. The body of a person with diabetes can handle sugar properly.
   c. Type 2 diabetes can be controlled.
   d. A person with type 2 diabetes has too much sugar in the blood.
   e. A person with type 2 diabetes can be harmed if the diabetes is not controlled.

2. Which of these is/are symptoms of uncontrolled diabetes?
   a. Feeling very thirsty.
   b. Having lots of energy.
   c. Needing to go to the toilet a lot.
   d. Putting on weight.

3. Which of these can be damaged in uncontrolled diabetes?
   a. Eyes.
   b. Ears.
   c. Lungs.
   d. Heart.
   e. Kidneys.
   f. Feet.

4. Which of these foods have a lot of sugar in them?
   a. Fruit juices.
   b. Chocolate bars.
   c. Potatoes.
   d. Artificial Sweeteners (eg. Equal, sucaryl).

5. Which of these foods have a lot of fat in them?
   a. Butter.
   b. Brown Bread.
   c. Margarine.
   d. Takeout/Fast Food.

6. Which of these put you at risk of getting diabetes?
   a. Being overweight.
   b. Being of European origin (white).
   c. Not doing exercise
   d. Having someone in your family with diabetes.
7. Which of these things can help you avoid diabetes?
   a. Losing weight.
   b. Drinking alcohol.
   c. Eating fried food.
   d. Doing regular exercise.

For this section, I would like you to **think about people in the general public** and **NOT** about your own personal risk of getting diabetes. Choose the number below the words that best describe your opinion about the item in relation to risk for type 2 diabetes.

<table>
<thead>
<tr>
<th></th>
<th>Increases the Risk</th>
<th>Has No Effect on the Risk</th>
<th>Decreases the Risk</th>
<th>Don’t Know</th>
<th>Unfamiliar With the Term Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Being Asian American</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Being Caucasian (White)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Being Black or African-American</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Being Hispanic</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Being American Indian</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Having a blood relative with diabetes</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Being 65 years of age or older</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Having high blood pressure</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Having high blood cholesterol</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Having most of your fat around your abdomen</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Having acanthosis nigrans, a dark leathery area under your neck.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Having polycystic ovarian syndrome, a problem with excess hair and irregular periods

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eating a healthy diet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercising regularly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controlling weight gain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

III. Physical Activity

Circle the responses that best describes your physical activity behaviors.

1. On how many of the past 7 days (1 week) have you engaged in at least 20 minutes of exercise or sport activities that resulted in sweat and heavy breathing?
   a. 0 Days
   b. 1 Day
   c. 2 Days
   d. 3 Days
   e. 4 Days
   f. 5 Days
   g. 6 Days
   h. 7 Days

2. On how many of the past 7 days (1 week) have you engaged in exercises to strengthen or tone muscles?
   a. 0 Days
   b. 1 Day
   c. 2 Days
   d. 3 Days
   e. 4 Days
   f. 5 Days
   g. 6 Days
   h. 7 Days

N.Fischetti 11.26.07
IV. Eating Habits

The following questions ask about what you drank over the past year. Please choose one response that best describes your drinking habits.

2. Over the past year how often did you drink not-diet soda/pop (1 can or individual bottle)?
   1. Never/less than 1 per month
   2. 1-3 bottles per month
   3. 1 bottle per week
   4. 2-4 bottles per week
   5. 5-6 bottles per week
   6. 1 bottle per day
   7. 2 bottles per day
   8. 3 or more bottles per day

3. Over the past year what was a usual serving size of the soda/pop you drank (any type)?
   1. <12 oz.
   2. 12oz. (e.g., can)
   3. 16-20 oz. (individual bottle)
   4. 21+ oz. (e.g., Big Gulp)
   5. Don’t know or don’t drink

4. Over the past year how often did you drink regular energy drinks- Red Bull, Rock Star (individual bottle)?
   1. Never/less than 1 per month
   2. 1-3 bottles per month
   3. 1 bottle per week
   4. 2-4 bottles per week
   5. 5-6 bottles per week
   6. 1 bottle per day
   7. 2 bottles per day
   8. 3 or more bottles per day

5. Over the past year how often did you drink a milkshake (1)?
   1. Never/less than 1 per month
   2. 1-3 per month
   3. 1 per week
   4. More than 1 per week
6. Over the past year how often did you drink smoothies (e.g., medium Jamba Juice or Orange Julius)?
   1. Never/less than 1 per month
   2. 1-3 bottles per month
   3. 1 bottle per week
   4. 2-4 bottles per week
   5. 5-6 bottles per week
   6. 1 bottle per day
   7. 2 bottles per day
   8. 3 or more bottles per day

For the following questions “sugar” refers to refined white sugar (table sugar), pure sugar cane (raw sugar), honey, sugar cane, Sweet One, Sunett, evaporated cane juice, agave nectar, date sugar maple syrup, molasses, corn syrup. **Do not** answer yes for non-caloric sweeteners such as Splenda, NutraSweet, Truvia, Pure Via, Sweet’N Low, Necta Sweet, Equal, Stevia, Nevella, etc.

7. Over the past year how often did you drink sugared iced-tea, fruit drinks, punch, lemonade, Sunny D, Kool-Aid, or other non-carbonated fruit drink-NOT JUICE (1 glass, can, or individual bottle)?
   1. Never/less than 1 per month
   2. 1-3 bottles per month
   3. 1 bottle per week
   4. 2-4 bottles per week
   5. 5-6 bottles per week
   6. 1 bottle per day
   7. 2 bottles per day
   8. 3 or more bottles per day

8. Over the past year how often did you drink non-diet sports drinks (e.g., Powerade or Gatorade) or sugar-sweetened vitamin water (individual bottle)?
   1. Never/less than 1 per month
   2. 1-3 bottles per month
   3. 1 bottle per week
   4. 2-4 bottles per week
   5. 5-6 bottles per week
   6. 1 bottle per day
   7. 2 bottles per day
   8. 3 or more bottles per day
9. Over the past year how often did you drink “sugar”- sweetened hot tea (include caffeinated and decaffeinated) (1 cup)?
   1. Never/ less than 1 per month
   2. 1-3 cups per month
   3. 1-2 cups per week
   4. 3-6 cups per week
   5. 1 cup per day
   6. 2 or more cups per day

10. Over the past year how often did you drink “sugar”- sweetened coffee (include caffeinated and decaffeinated) (1 cup)?
    1. Never/ less than 1 per month
    2. 1-3 cups per month
    3. 1-2 cups per week
    4. 3-6 cups per week
    5. 1 cup per day
    6. 2 or more cups per day

11. Over the past year how often did you drink “sugar”- sweetened coffee drinks with whole milk, e.g., Cappuccino, Mocha, Latte?
    1. Never/ less than 1 per month
    2. 1-3 cups per month
    3. 1-2 cups per week
    4. 3-6 cups per week
    5. 1 cup per day
    6. 2 or more cups per day

12. Over the past year how often did you drink “sugar”- sweetened iced coffee with whole milk, e.g., Coffee, Coolatta, Frappuccino?
    1. Never/ less than 1 per month
    2. 1-3 cups per month
    3. 1-2 cups per week
    4. 3-6 cups per week
    5. 1 cup per day
    6. 2 or more cups per day
13. Over the past year how often did you drink **beer** (1 glass, bottle, or can)?
   1. Never/ less than 1 per month
   2. 1-3 cans per month
   3. 1 can per week
   4. 2-4 cans per week
   5. 5-6 cans per week
   6. 1 can per day
   7. 2 cans per day
   8. 3 or more cans per day

14. Over the past year how often did you drink **wine** or **wine coolers** (1 glass)?
   1. Never/ less than 1 per month
   2. 1-3 glasses per month
   3. 1 glass per week
   4. 2-4 glasses per week
   5. 5-6 glasses per week
   6. 1 glass per day
   7. 2 glasses per day
   8. 3 or more glasses per day

15. Over the past year how often did you drink **liquor**, like vodka or rum (1 drink, 1 shot, 1 bottle)? Include ready drink alcoholic beverages like Hard Lemonade.
   1. Never/ less than 1 per month
   2. 1-3 drinks per month
   3. 1 drink per week
   4. 2-4 drinks per week
   5. 5-6 drinks per week
   6. 1 drink per day
   7. 2 drinks per day
   8. 3 or more drinks per day

The following questions ask about what you ate over the past year. Please choose one response that best describes your eating habits.

16. Over the past year how often did you eat **potato chips** (1 small bag)?
   1. Never/less than 1 per month
   2. 1-3 small bags per month
   3. One small bag per week
   4. 2-6 small bags per week
   5. 1 or more small bags per day
17. Over the past year how often did you eat corn chips/ Doritos (1 small bag)?
   1. Never/less than 1 per month
   2. 1-3 small bags per month
   3. One small bag per week
   4. 2-6 small bags per week
   5. 1 or more small bags per day

18. Over the past year how often did you eat popcorn (1 small bag)?
   1. Never/less than 1 per month
   2. 1-3 small bags per month
   3. 1-4 small bags per week
   4. More than 4 small bags per week

19. Over the past year how often did you eat pretzels (1 small bag)?
   1. Never/less than 1 per month
   2. 1-3 small bags per month
   3. 1 small bags per week
   4. More than 1 small bags per week

20. Over the past year how often did you eat crackers, e.g., Wheat Thins or Ritz, Cheez-Its, soda crackers, Saltines (1 serving)?
   1. Never/less than 1 per month
   2. 1-3 times per month
   3. 1-4 times per week
   4. More than 4 times per week

21. Over the past year how often did you eat graham crackers (2 squares)?
   1. Never/less than 1 per month
   2. 1-3 times per month
   3. 1-4 times per week
   4. More than 4 times per week

22. Over the past year how often did you eat poptarts (1)?
   1. Never/less than 1 per month
   2. 1-3 poptarts per month
   3. 1-6 poptarts per week
   4. 1 or more poptarts per day

23. Over the past year how often did you eat cake (1 slice) or cupcake (1)?
   1. Never/less than 1 per month
   2. 1-3 slices per month
   3. 1 slice per week
   4. More than 1 slice per week
24. Over the past year how often did you eat **snack cakes**, like Ring Dings/Swiss Rolls/Twinkies (1 package)?
   1. Never/less than 1 per month
   2. 1-3 per month
   3. One per week
   4. 2-6 per week
   5. 1 or more per day

25. Over the past year how often did you eat **danish, cinnamon rolls, pastry** (1)?
   1. Never/less than 1 per month
   2. 1-3 per month
   3. 1 per week
   4. 2-4 per week
   5. More than 4 per week

26. Over the past year how often did you eat **donuts** (1) or **churros** (1 serving)?
   1. Never/less than 1 per month
   2. 1-3 per month
   3. 1 per week
   4. 2-6 per week
   5. More than 1 per day

27. Over the past year how often did you eat **cookies** (1)?
   1. Never/less than 1 per month
   2. 1-3 cookies per month
   3. 1 cookie per week
   4. 2-6 cookies per week
   5. 1-3 cookies per day
   6. More than 3 cookies per day

28. Over the past year how often did you eat **brownies** (1)?
   1. Never/less than 1 per month
   2. 1-3 per month
   3. 1 per week
   4. 2-4 per week
   5. More than 4 per week

29. Over the past year how often did you eat **pie** or **fruit crisp** (1 serving)?
   1. Never/less than 1 per month
   2. 1-3 slices per month
   3. 1 slice per week
   4. More than slice 1 per week
30. Over the past year how often did you eat **chocolate** like Hershey’s or M & M’s (1 bar or packet)?
   1. Never/less than 1 per month
   2. 1-3 per month
   3. 1 per week
   4. 2-6 per week
   5. 1 or more per day

31. Over the past year how often did you eat **other candy bars** like Milky Way, Snickers (1 bar)?
   1. Never/less than 1 per month
   2. 1-3 candy bars per month
   3. 1 candy bar per week
   4. 2-6 candy bars per week
   5. 1 or more candy bars per day

32. Over the past year how often did you eat **other candy without chocolate** like Skittles (1 pack)?
   1. Never/less than 1 per month
   2. 1-3 times per month
   3. Once per week
   4. 2-6 times per week
   5. 1 or more times per day

33. Over the past year how often did you eat **Jello** (not “sugar-free”) (1 serving)?
   1. Never/less than 1 per month
   2. 1-3 times per month
   3. Once per week
   4. 2-4 times per week
   5. More than 4 times per week

34. Over the past year how often did you eat **pudding** or **pudding pops** (not “sugar-free”) (1 serving)?
   1. Never/less than 1 per month
   2. 1-3 times per month
   3. Once per week
   4. 2-4 times per week
   5. More than 4 times per week
35. Over the past year how often did you eat **ice cream** or **frozen yogurt** (not low-fat or not “sugar-free”) (1 serving)?
   1. Never/less than 1 per month
   2. 1-3 times per month
   3. Once per week
   4. 2-4 times per week
   5. More than 4 times per week

36. Over the past year how often did you eat **popsicles, ice pops, fudgesicles** (1)?
   1. Never/less than 1 per month
   2. 1-3 per month
   3. 1 per week
   4. 2-4 per week
   5. More than 4 per week

37. Over the past year how often did you eat **snack bars** (e.g., Nutrigrain, granola, Kashi, Planters) (1)?
   1. Never/less than 1 per month
   2. 1-3 times per month
   3. 1 time per week
   4. 2-4 times per week
   5. More than 4 times per week

38. Over the past year how often did you eat **energy bars** (e.g., Cliff, Luna, Glucerna, Powerbar) (1)?
   1. Never/less than 1 per month
   2. 1-3 times per month
   3. 1 time per week
   4. 2-4 times per week
   5. More than 4 times per week

39. Over the past year how often did you eat **high protein bars** (e.g., Atkins, Zone, South Beach) (1)?
   1. Never/less than 1 per month
   2. 1-3 times per month
   3. 1 time per week
   4. 2-4 times per week
   5. More than 4 times per week
40. Over the past year how often did you eat **processed fruit snacks** or **fruit rollups** (1 pack)?
   1. Never/less than 1 per month
   2. 1-3 packs per month
   3. 1-4 packs per week
   4. More than 4 packs per week

41. Over the past year how often did you eat **Jams, jellies, fluff, syrup** or **honey** (Tbs.)?
   1. Never/less than 1 per month
   2. 1-3 per month
   3. 1 per week
   4. 2-4 per week
   5. More than 1 per day

42. How often do you eat **food that is fried at home, in dorm, and at dining hall**,
    like fried chicken?
   1. Never/less than once per week
   2. 1-3 times per week
   3. 4-6 times per week
   4. Daily

43. How often do you eat **fried food away from home, at a restaurant and at bar**
    (like French fries, chicken wings, chick nuggets)?
   1. Never/less than once per week
   2. 1-3 times per week
   3. 4-6 times per week
   4. Daily
Appendix F

SUNY Oswego’s IRB Approval to Sample Subjects

Human Subjects Expedited Review Form

DATE: 01/15/2015

TO: Ms. Elizabeth Keola

FROM: Dr. David Bozak, Chair, Human Subjects Committee

RE: Knowledge of risk factors related to Type 2 Diabetes (20150619b1)

Your above titled research project has been received for expedited review and:

X has been approved ______ needs further revision (see reasons below)

Please follow these steps:

1. You keep this top page ("Expedited Review Form") for your records.
2. Prior to conducting the research, complete the attached "Acceptance of Review by Principle Investigator" and return it to:

Dr. David Bozak
Chair, Human Subjects Committee
414 Mahor Hall
State University of New York at Oswego
Oswego, NY 13126
david.bozak@oswego.edu

Thank you.

[Signature]

David Bozak
Appendix G

IRB Online Course

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that Elizabeth Keida successfully completed the NIH Web-based training course “Protecting Human Research Participants”.

Date of completion: 01/15/2015

Certification Number: 1651263