A Comprehensive Test of the Health Belief Model and Selected Environmental Factors in the Prediction of Physical Activity and Dietary Behavior of Saudi Arabian University Students in the United States

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by

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LIST OF ABBREVIATIONS

ADA: American Diabetes Association

BMI: Body Mass Index

CAD: Coronary Artery Disease

CDC: Centres for Disease Control

CVD: Cardiovascular Diseases

DBP: Diastolic Blood Pressure

DM: Diabetes Mellitus

DPP: Diabetes Prevention Program

DR: Diabetic Retinopathy

EMRO: Eastern Mediterranean Regional Office

FPG: Fasting Plasma Glucose

GCC: Gulf Countries

GDM: Gestational Diabetes Mellitus

HbA1c: Haemoglobin A1c

HBM: Health Belief Model

HDL: High-Density Lipoprotein

HP: Healthy People 2030

IDF: International Diabetes Federation

IFG: Impaired Fasting Glucose

IGT: Impaired Glucose Tolerance

LDL: Low-Density Lipoprotein

MENA: Middle Eastern And North African Countries

MOH: Ministry of Health In Saudi Arabia

NCDs: Centers of Noncommunicable Diseases

NICU: Neonatal Intensive Care Unit

OGTT: Oral Glucose Tolerance Test

PA: Physical Activity

PI: Principle Investigator

PVD: Peripheral Vascular Disease

RPG: Random Plasma Glucose

SA: Saudi Arabia

SBP: Systolic Blood Pressure

T1DM: Type 1 Diabetes

T2DM: Type 2 Diabetes

TG: High Triglycerides

U.S.: United States

USPSTF: United States Services Task Force

WHO: World Health Organization

YMCA: Young Men's Christian Association

DEDICATION

This dissertation is dedicated to my mother Ebtesam Gari. Without her endless love and encouragement, I would never have been able to complete my studies. I appreciate everything you have done for me.

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Chapter 1

Introduction

Introduction

Diabetes mellitus (DM) is a significant public health concern affecting quality of life (Khamaiseh & Alshloul, 2019). Diabetes is a metabolic disorder characterized by insufficient insulin production, defects in insulin secretion, or both associated with excess mortality, morbidity, vascular complications, terrible general health issues, and decreased quality of life (World Health Organization, 2021). There are several types of diabetes, of which Type 2 Diabetes (T2DM) is the most prevalent type that has become an epidemic worldwide (Roden & Shulman, 2019). Physical inactivity, unhealthy dietary habits, obesity, genetic predisposition, and other environmental and behavioral factors may contribute to T2DM (Schellenberg et al., 2013; Hu et al., 2001). Many life-threatening complications such as coronary artery diseases, strokes, kidney diseases, nephropathy, and retinopathy can be caused by diabetes. Death is also one of the potential outcomes of diabetes (American Diabetes Association ADA, 2020; Asfandiyarova, 2016).

T2DM is often asymptomatic and undetected for many years, and most diabetics are unaware of their diseases (Bennett, Guo, & Dharmage, 2007), but microvascular complications can be developed during an asymptomatic period. About 85 to 95% of undiagnosed individuals with T2DM go through a symptomatic period of sub-clinical stages, which may increase the risk of diabetes complications without early diagnosis (Guariguata, 2013). It has been found that untreated people with Impaired glucose tolerance (IGT) are more likely to develop T2DM in 10 years (Goodarzi, 2014).

Health determining factors and health disparities are the major causes of illnesses in most Middle Eastern and North African countries (MENA); however, in Saudi Arabia (SA), the case differs as it was found that the high burden of diseases was due to lifestyle-related risk factors (Tyrovolas et al., 2020). Over the past few decades, a cultural shift in SA has influenced the Saudi lifestyle. At the core of this shift are factors such as urbanization, high demand for automobiles for transportation, more extensive use of technologies, a combination of traditional cultural practices, and the availability of fatty food leading to an increased incidence and prevalence of diseases and health issues (Al-Hazzaa, & Musaiger, 2010; DeNicola et al., 2015). Unhealthy eating habits, physical inactivity, and psychological and socioeconomic factors were significantly associated with unhealthy lifestyles (Alzahrani et al., 2020). For example, the adoption of a sedentary lifestyle has increased the diabetes prevalence in urban areas (25.5%) than in rural areas (19.5%) (Al-Nozha et al., 2004; Al-Hazzaa & Musaiger, 2010).

Obesity has a significant association with the development of T2DM. It is estimated that the prevalence of obesity-related diabetes will increase globally to 300 million by 2025 (Dyson, 2010). The percentage of adults that are obese in the Saudi population is 52.9% and is expected to reach 59.5% by 2022 (Alqarni, 2016). Studies found that obesity in females (71%) is higher than in males (56.2%), and the percentages are projected to increase in males and females by 2022 (Ahmed et al., 2014; Al-Quwaidhi et al., 2013). Although the high prevalence of obesity, diabetes, high cholesterol, and hypertension has been reported in Saudi Arabia, few people sought preventive medical care, so many had undiagnosed chronic diseases, including diabetes (Al-Hazzaa & Musaiger, 2010).

Despite the increasing occurrences of the disease, several intervening factors have been found helpful in combating the growth of T2DM. According to *Healthy People 2030,* education, environment, social support, and availability of community-based resources are essential factors needed to promote good health. Unfortunately, in Saudi Arabia, there is a lack of social determinants such as a healthy environment and a lack of health education and promotion programs and social support, which may increase the risk of T2DM among nondiabetics and hinder people with diabetes from managing their disease (Mujammami et al., 2020).

The sooner the diagnosis and screening for those factors, the better the long-term outcomes, especially in high-risk populations (Latachan et al., 2010). Lifestyle modification is cost-effective and essential in the early diagnosis, management, and improving an individual's health outcomes (Moncrieft et al., 2016). Assessing risk factors among high-risk groups helps develop policy and implement programs related to T2DM (Green, Brancati, & Albright, 2012).

There is limited literature that assessed the relationship between health beliefs and people's behaviors in the context of the Saudi culture (Alatawi et al., 2015; Al-Mutairi et al., 2015; Albargawi, 2017), and from those only one study targeted adolescents (Al-Mutairi et al., 2015). Additionally, the association between environment and health behaviors was not examined in the literature review that used HBM as a framework. No previous study has assessed the association between health beliefs and health behaviors among Saudi international college students in U.S. universities. Therefore, this correlational study examines the influence of health beliefs and other factors such as demographic, knowledge, and environmental factors on physical activity and dietary behavior among Saudi college students living in the United States using the Health Beliefs Model (HBM).

Problem Statement

Globally, Saudi ranked seventh in the top 10 countries affected by DM and is estimated to be sixth by 2035 (Aguiree et al., 2013). Today, the current population of Saudi Arabia is 35,181,427, and 18.3% are affected by DM, which means 4,275,200 total cases (IDF, 2020). T2DM represents the most prevalent type in SA, with 67% of DM cases (El Bcheraoui et al., 2014). It is estimated that the overall prevalence of T2DM in SA will increase to 40 % by 2022 if the prevalence of obesity and smoking remains high (Al-

Quwaidhi et al., 2013). In addition, in 2013, the prevalence of T2DM among younger aged 20 and older was reported as 24% (El Bcheraoui et al., 2015; Alotaibi et al., 2017).

Saudi Arabia has a large youth population, so these issues must be addressed. Around 60% of the Saudi population is aged 35 or younger, including college students, which means their need for health care services is increasing (Colliers, 2019). In one study in SA, 18 and 24 years old were more vulnerable to T2DM as they reported a high prevalence of prediabetes at 19%; however this percentage is limited to females only (Al-Zahrani et al., 2019). Diabetes risk scores are from moderate to high among 16% of college students in Saudi Arabia; however, the scores are limited to medical students (Mirghani & Saleh, 2020). Obesity and being overweight, the strongest predictors of T2DM, were also found high among younger ages in SA; more than one-third of the students were overweight and obese at 21.8% and 15.7%, respectively (Al-Rethaiaa, Fahmy & Al-Shwaiyat, 2010). These numbers are significant because the burden of T2DM and the cost of treatment will increase if young people remain unaware of preventive measures to control their behaviors and if no prevention programs are established.

In Saudi Arabia, many challenges such as growing prevalence, lifestyle changes, late diagnosis, high treatment costs, diabetes complications, and poor awareness must be addressed to prevent diabetes (Alwin et al., 2017). Although efforts have been established to combat T2DM by the Ministry of Health in Saudi Arabia in recent years (MOH, 2013), the focus of those efforts was at a secondary and tertiary level of prevention that targeted older adults and diabetes patients. However, the overall burden of DM also affects the middle age group, and college students are one of the central populations threatened by T2DM. College students are an unexplored population regarding T2DM in terms of the prevention intervention programs and assessment of risk factors (Kutbi et al., 2018). This group also faces additional challenges during college life, including difficulty adapting to life in a new environment, impacting their health as they engage in unhealthy lifestyles (Greaney et al., 2009). Data shows a high prevalence rate of prediabetes among 18 years old or older in 2011; around 3,600 were diagnosed with T2DM at young ages (CDC, 2011). In the United States, the overall prevalence of prediabetes affects about 1in 4 (24%) young adults aged 19 to 35 years old (Andes et al., 2020).

Evidence has shown that a promising approach for addressing diabetes mellitus is to create knowledgeable individuals by communicating relevant statistics concerning the disease, symptoms, complications, prevention, and treatment (Lambrinou, Hansen & Beulens, 2019). However, there is a lack of knowledge of risk factors and complications related to diabetes among college students globally and in Saudi Arabia (Mohieldein, Alzohairy & Hasan, 2011; Wadaani, 2013; Khamaiseh & Alshloul, 2019). There is also a lack of health education programs about diabetes and obesity at colleges in SA (Almutairi et al., 2018). Therefore, this study examined the impact of health beliefs and other factors such as demographics, knowledge, and environmental factors on T2DM prevention behaviors in Saudi college students in the United States.

Research Questions and Hypotheses

1- What is the association between students' risk factors (i.e., age, gender, family history, major, level of stress, BMI, knowledge, and environmental variables) and physical activity and dietary habits in Saudi Arabian university college students living in the United States?

Hypotheses A:

Null Hypotheses: There is no association between students' risk factors and physical activity.

Alternative Hypotheses: Risk factors are significantly associated with students' physical activity.

Hypotheses B:

Null Hypotheses: There is no association between students' risk factors and dietary habits.

Alternative Hypotheses: Risk factors are significantly associated with students' dietary habits.

2- Is there an association between health beliefs (i.e., perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and self-efficacy) and physical activity and dietary habits among the selected population?

Hypotheses 1a:

Null Hypotheses: There is no association between students' perceived susceptibility, severity, benefits, self-efficacy, and physical activity.

Alternative Hypotheses: The greater the students' perceived susceptibility, severity, benefits, and self-efficacy toward T2DM, the more likely they are to follow the recommended physical activity.

Hypotheses 1b:

Null Hypotheses: There is no association between students' perceived susceptibility, severity, benefits, self-efficacy, and dietary habits.

Alternative Hypotheses: The greater the students' perceived susceptibility, severity, benefits, and self-efficacy toward T2DM, the more likely they are to eat healthily.

Hypotheses 2a:

Null Hypotheses: There is no association between students' perceived barriers and physical activity.

Alternative Hypotheses: The lower the barriers students report, the more likely they are to follow the recommended physical activity.

Hypotheses 2b:

Null Hypotheses: There is no association between students' perceived barriers and dietary habits.

Alternative Hypotheses: The lower the barriers students report, the more likely they are to eat healthily.

Chapter Summary

T2DM is a public health concern that affects the Saudi community. Diabetes adversely affects patients, their families, and the economy. It is essential to understand the relationship between health beliefs and other risk factors leading to T2DM and people's behaviors, especially those at high risk of T2DM, such as college students, to combat the T2DM issue. This chapter provided an introduction and the background for the study. The chapter also addressed the problem statement, the study's implications, research questions, and hypotheses.

Chapter 2

Literature Review

Introduction

This study examines the effect of health beliefs and other factors such as personal and environmental variables on Saudi college students' physical activity and dietary behavior in the United States. The first section provides an overview of diabetes as a disease, T2DM, the prevalence of diabetes globally and among the Saudi population, economic burden, complications, risk factors in general and specific to the Saudi culture, the treatment, prevention, and other preventive measures. The second section covers health policy in Saudi Arabia, the background of the Saudi community in the U.S., and gaps in the literature review. The third section discusses the literature on the Health Belief Model and a modified model that reflects the purpose of the study.

Diabetes

Diabetes mellitus is a significant public health problem that harms the quality of life (Khamaiseh & Alshloul, 2019). Diabetes is a group of diseases characterized by hyperglycemia due to insufficient production of insulin, defects in insulin secretion, or both. Diabetes is also known as insulin resistance which begins when the body cells misuse the insulin. In 2014, the World Health Organization defined the high-risk state of hyperglycemia as either impaired fasting glucose (IFG) which is known as fasting plasma glucose 5.6 to 6.9 mmol/L, or impaired glucose tolerance (IGT), known as plasma glucose 7.8 to 11.0 mmol/L within two hours after drinking 75g of dextrose. The insulin resistance mechanism reduces the pancreas's ability to produce insulin while the need for insulin increases, leading to severe complications and even death. Early preventive measures are essential in reducing the morbidity and mortality related to diabetes (Dagogo-Jack, 2002).

Types of Diabetes

The types of diabetes include prediabetes, diabetes mellites Type 1 (T1DM), diabetes mellites Type 2 (T2DM), and gestational diabetes (GDM), which is a metabolic syndrome. Pre-diabetes is a condition where the blood glucose level is higher than normal but below the diabetes threshold, and the risk of diabetes is high among prediabetic individuals (Bansal, 2015). Normal blood sugar is between 70 mg/dl to less than 100 mg/dL; however, in prediabetic patients, the blood glucose level is elevated between 110 mg/dL to 125 mg/dL (American Diabetes Association, 2014). Prediabetes leads to severe consequences if it remains undiagnosed, and diagnosed patients should check the progression of the disease annually or every two years. According to United States Services Task Force (USPSTF), the screening should be repeated every three years to ensure a negative result. Unhealthy lifestyles, being overweight and obese, gestational diabetes, hypertension, and dyslipidemia are all risk factors for prediabetes and T2DM, and prediabetics will develop into T2DM in 5 years if diagnosed and do not modify their lifestyle (CDC, 2019; Albert, 2016). A recent study among Saudi females found prediabetes prevalence at 18.8%. Furthermore, the prevalence has increased in those older than 50 years old and was also associated with a family history of dyslipidemia in females and cardiovascular disease in males (Al-Zahrani et al., 2019; Bahijri et al., 2016). Lifestyle interventions for a year show a significant reduction in the prediabetes prevalence in the Saudi population (Amer et al., 2020; Alzeidan et al., 2019)

The next type of diabetes, type 1 diabetes (T1DM), is defined as insulin deficiency due to autoimmune destruction of pancreatic β-cells leading to hyperglycemia and a tendency to ketosis (ADA,b 2014). About 5% to 15% of diabetic patients were diagnosed with type 1. Although the diseases can occur at any age, it commonly occurs in children and adolescents (ADA, 2009). Although the cause and risk factors of T1DM are not fully understood, genetic markers significantly affect the disease (ADA,b 2014; ADA, 2009). The life expectancy of T1DM patients is 12 years less on average than others (Huo et al., 2016). Saudi Arabia ranked 8th in type 1 diabetic patients and ranked 4th in the world in the incidence rate of T1DM (33.5 per 100,000) (Robert et al., 2018)

The most prevalent type, T2DM, constitutes 90% of all diabetes cases and is defined as insulin resistance due to insulin insufficiency as a result of obesity, physical inactivity, and poor diet, which are the leading cause of cardiovascular diseases (CVD), kidney failure, blindness, and lower limbs amputation (Goyal & Jialal, 2021). Evidence has shown that lifestyle modification, including weight loss, physical activity, and a healthy diet, contributes to preventing and the delayed occurrence of T2DM (Balk et al., 2015).

The final type of diabetes, Gestational Diabetes (GDM), is the degree of glucose intolerance that occurs for the first time during pregnancy due to pancreatic B-cell dysfunction or blocking of insulin action due to placenta hormone action. There are two categories of Gestational diabetes, A1GDM and A2GDM. A nonpharmacologic approach is a way to manage A1GDM; however, medication is essential for controlling A2GDM (Rodriguez & Mahdy, 2021). The risk of T2DM has been found to increase 3 to 7 times within 5 to 10 years for those diagnosed with GDM (Curry, 2015). Approximately 7% of pregnant women are diagnosed with GDM, representing more than 200,000 total cases yearly; however, the U.S. only records about 7-14% of GDM cases annually (Chen et al., 2015). Generally, there are no symptoms; however, testing for it is crucial to prevent the potential risk of hypertension during pregnancy, cesarean sections (C-section), T2DM, later on, macrosomia, admission to neonatal intensive care unit (NICU), and perinatal mortality (CDC, 2019; Wahabi et al., 2013; Wahabi et al., 2012). Alfadhli et al. (2015) and Mahzari et al. (2018) show that the risk of gestational diabetes increases with body weight, BMI, family history of diabetes, and diastolic blood pressure. On the other hand, another study found that gestational diabetes among Saudi women is not associated with hypertension, family history of diabetes, working status, or place of living (Abualhamael et al., 2019). However, all studies agree with the high prevalence rate of gestational diabetes among Saudi women regardless of the reason, as GDM is 12.75% (Abualhamael et al., 2019; Alfadhli et al., 2015). Therefore, early screening for gestational diabetes helps prevent further complications for a mother and a child.

Prevalence of diabetes

A chronic endocrine disorder causes diabetes, affecting about 5%–10% of adults worldwide, as an estimated (Shaw, Sicree & Zimmet, 2010). The global prevalence of diabetes is further projected to increase to 10.2% (578 million) by 2030 and 10.9 % (700 million) by 2045 from 9.3 % (463 million) in 2019 (IDF, 2019). According to the International Diabetes Federation (2017), about 8.8 % of adults over 20 have diabetes mellites. The predictions have shown that between 2010 and 2030, developed and developing countries will show a 20% and 69% increase, respectively (Shaw, Sicree & Zimmet, 2010). It is estimated that the number of people with T2DM alone will increase from 366 million in 2011 to 552 million in 2030 globally (Whiting et al., 2011).

DM affects 463 million adults aged 20 years and above worldwide, with 79% living in developing countries (IDF, 2019). Interestingly, in developing countries, the disease impacts younger ages between 35 and 64 compared to the same age group in developed countries (Rawal et al., 2012). In 2017, the prevalence rate of DM in the Gulf countries (GCC) was reported as the following: Oman 29%, Kuwait 25.4%, Bahrain 25%, the United Arab Emirates 25%, and Qatar 16.7% (Meo et al., 2017). In comparison to other gulf countries, Saudi Arabia had the highest prevalence rate of 31.6%, and more than 31% of the Saudi population suffers from diabetes in one form or another (Meo et al., 2017).

A study conducted on a national level to examine the diabetes epidemic status among people 15 years and older from all 13 regions in Saudi Arabia found that out of 10,735,00 participants, the number of prediabetes cases was 979,953. There were 1,745,532 diabetic cases, where 67% of them had T2DM, 13% had T1DM, and 20% did not know their type of DM (El Bcheraoui et al., 2014). The burden of T2DM differs based on geographical area, socio-demographic characteristics, socioeconomic status, and gender. The prevalence rate was higher among individuals living in an urban area with a low monthly income of less than $1,066 (27%) compared to those who were living in a rural area with the same income (26%) (Al-Rubeaan, 2014). Other significant differences noted include the burden of DM amongst the regions in Saudi Arabia. For example, the northern region of SA had the highest prevalence rate of T2DM, while the least was in the southern region (Al-Nozha et al., 2004). Furthermore, there are significant socioeconomic inequalities in the prevalence of DM in the Saudi population. For instance, the high prevalence of the disease was reported by the unemployed (32%), individuals with low education level (32%), divorced and widowed (56.3%), and low income (42.4%) (Al-Baghli et al., 2010; Al-Hanawi et al., 2020; Al Mansour, 2020).

Age and gender are also associated with the burden of T2DM. A high prevalence rate of T2DM was found among mean age 52 years (Alshammari & Alnasser, 2021). A recent study also found that DM prevalence increased between 25 to 44 years old (Al-Zahrani et al., 2019). Although a few studies have assessed the prevalence of T2DM between genders in SA, there is disagreement. For example, Al-Rubeaan (2015) found that females have a higher prevalence rate for T2DM than males. In contrast, Alqurashi et al., 2011, found that males had a higher prevalence of T2DM than females with 34% and 28%, respectively.

The economic burden of diabetes

The high prevalence of disease impacts the health system. Diabetic patients represent about 8.8% of the population globally, and the number of diabetic patients is estimated to be 642 million worldwide by 2040 (Ogurtsova et al., 2017). Diabetes and its complications threaten the global economy and health (WHO, 2018). In 2011, deaths from DM were about 4.6 million worldwide, while the economic healthcare burden was $465 million as a minimum expenditure among adults globally (IDF, 2011). In 2019, about 10% of the economic healthcare burden was spent on adult diabetes patients 20-79 years. The global minimum health expenditures were $760 billion in 2019. It is projected to increase to $825 billion by 2030 and $845 by 2045 (IDF, 2019). In the United States only, the direct medical costs of diabetes are $237 billion per year and $90 billion in indirect costs (ADA, 2018). In Saudi Arabia, the total healthcare budget is $48 billion, and about $7 billion (13.9%) of the total healthcare budget is utilized for the entire population of DM patients in Saudi Arabia; however, this amount would increase to $7.2 billion if undiagnosed people were involved in the treatment plan (Alwin et al., 2017). Healthcare expenditures on DM cases will increase to $11.4 billion if prediabetics become diabetic patients (Mokdad et al., 2015). The average healthcare costs of diabetic patients are ten times higher than non-diabetics ($3,686 vs. $380); the highest age group was 45-60 (45%), followed by age 15-44 (27.5%) (Alhowaish, 2013). The indirect cost includes productivity in society, such as loss of productivity from disease-related absenteeism, unemployment due to disease disability, and social costs such as pain and suffering, health care systems administration, and medication costs (Alhowaish, 2013).

Diabetes Complications

Complications of T2DM can be categorized as macrovascular such as coronary artery disease, hypertension, stroke, and peripheral vascular disease, and microvascular complications, such as nervous system damage (neuropathy), renal system damage (nephropathy), and eye damage (retinopathy), along with death (ADA, 2006; Asfandiyarova, 2016). Studies from different countries found a high prevalence of vascular complications, with 73.2% microvascular, 57.5%, and macrovascular, 51.4% (Li et al., 2020; Kang et al., 2005). Similarly, studies conducted in Saudi Arabia show that microvascular complications are higher than macrovascular (Alaboud et al., 2016; Khan et al., 2010). The following sections discuss the most common complications associated with T2DM.

Coronary artery disease (CAD) occurs as a result of built-up plaque. Approximately 32.2% of all diabetic patients are also diagnosed with CAD, and the annual percentage of CAD is 1.4% to 4.7%. Most of these patients are middle-aged, and the death rate due to CAD is 9.9% (Akalu & Birhan, 2020; Einarson et al., 2018; Patoulias et al., 2020). According to the American Heart Association, the risk factors most associated with CAD are smoking, hypercholesteremia, hypertension, family history, and diabetes, as it was found to be higher among patients with T2DM than non-diabetics (Leon & Maddox, 2015; De Backer et al., 2003). The risk increased among women (Kannel & McGee, 1979). In the Saudi context, the age-adjusted incidence of coronary heart disease is 24% among the population (Alsenany & Al Saif, 2015). Additionally, there is a significant association between a history of diabetes and the risk of CAD (Hajar, 2017). In Saudi Arabia, it has been found that diabetes is associated with an increase in the risk of CAD among young ages by 47.2 % (Almalki et al., 2019).

Another diabetes complication is hypertension, one of the most common complications related to T2DM. Hypertension occurs twice more frequently among diabetic patients than non-diabetics (Petrie, Guzik & Touyz, 2018). About 85% of patients with DM have developed hypertension later in life (Mitchell et al., 1990). The age-adjusted incidence of hypertension among Saudi diabetics is 38%, and the onset of diabetes among patients was 34 years old among males and 39 years old in females (Alsenany & Al Saif, 2015). American

Diabetes Association guidelines (2018) recommend that diabetic patients lower their blood pressure to SBP less than 140 mmHg and DBP less than 90 mmHg.

Diabetes can also increase stroke rates. A stroke is the second cause of death and the first cause of disability globally (Zuhaid et al., 2014). It occurs when clots form and block the brain arteries. Ischemic strokes constitute 85% to 90% of strokes in developed countries (Alam et al., 2004). Hyperglycaemia in diabetes is well determined as a risk factor for strokes. The mortality rate of strokes due to diabetes in the United States is 65% (Chen, Ovbiagele & Feng, 2016). The prevalence of strokes among patients with DM in Saudi Arabia is 59% (Alharbi et al., 2019).

Peripheral vascular disease (PVD) is one of the common complications among diabetic patients, and hyperglycemia leads to an alteration in the peripheral blood vessels (Paneni, Costantino & Cosentino, 2014). The key factors associated with PVD are endothelial and vascular smooth muscle dysfunction, inflammation, and hypercoagulability. PVD increases the risk of gangrene and amputation (Huysman & Mathieu, 2009). Saudi Arabia, in this regard, shows 33.3% of PVD in diabetic patients and 6.9% had amputations, which is slightly higher among Saudi patients than in other ethnic groups 5% (Alsadiqi et al., 2019; Swaminathan et al., 2014).

A further diabetic complication impacts eyesight. Diabetic retinopathy (DR) develops due to damage to the blood vessels of the light-sensitive tissues in the eyes due to the long duration of diabetes mellites and poor control of glycemia (Diabetes Control and Complications Trial Research Group, 1995; Rani et al., 2009). Blurry vision and even blindness can occur from hyperglycemia. The prevalence of diabetic retinopathy associated with T2DM is 25.1%, and it is estimated that about 25% to 30% of those patients may develop diabetic macular edema (Wilkinson-Berka & Miller, 2008). In Saudi Arabia, the prevalence of diabetic retinopathy among diabetic patients is 19.7% (Al-Rubeaan et al., 2014).

Vascular diseases also become prevalent in diabetic patients. Diabetic nephropathy is one of the most common vascular complications among diabetic patients, and it could develop in about 30% to 40% of patients with diabetes (Umanath & Lewis, 2018). The prevalence of diabetic nephropathy was high among Saudi diabetic patients at 42.5%, increasing with age, duration of diabetes, body mass index (BMI), and low monthly income (Al-Sayyari & Shaheen, 2011; Al-Rubeaan et al., 2018). Another vascular complication is diabetic neuropathy, defined as dysfunction of the nervous system that leads to numbness, tingling, and a burning sensation in the extremities (Wang et al., 2018; Bodman & Varacallo, 2020). The leading cause of foot ulcers and wound infections among patients with diabetes is diabetic neuropathy (Amin & Doupis, 2016). Diabetic neuropathy among patients with T2DM in SA is 35% (Algeffari, 2018).

Risk Factors for T2DM

The risk factors of T2DM may differ from developed to developing countries and from one geographical area to another based on lifestyle, beliefs, culture, religion, life expectancy, and socioeconomic status. According to the CDC (2020), T2DM is caused by several non-modifiable factors (i.e., age over 45 years, race, family history, and gestational diabetes), in addition to common modifiable factors (i.e., overweight, physical inactivity, prediabetes). The American Diabetes Association added other modifiable factors such as high blood pressure, high cholesterol, and the body shape "apple." Previous studies defined smoking, stress, culture, and urbanization as additional risk factors for T2DM (Arslanian, 2002; Gulli et al., 1992; Issaka et al., 2018; Jazieh et al., 2012; Al-Hazzaa, & Musaiger, 2010; DeNicola et al., 2015).

Age is a nonmodified risk factor for T2DM as it is typically more prevalent after 45 years old. As people age, they become frailer, and frailty is a physiological vulnerability to stressors resulting in adverse outcomes such as disability and mortality from diabetes and other chronic conditions, and loss of muscle mass and decreased physical activity tend to increase the risk of hyperglycemia with aging (Fried et al., 2001; Kuo, 2009). However, T2DM also occurs in children, adolescents, and younger adults due to high-calorie food, obesity, and physical inactivity (Goyal & Jialal, 2019).

Race is another risk factor for T2DM that affects any group; however, the prevalence increased among ethnic groups such as African Americans, Native Americans, and Hispanic Americans. Health care access, medical insurance, health care services, and other health disparities increase the risk of chronic diseases, including T2DM among those populations in the U.S., and minority groups are at higher risk of diabetic retinopathy, diabetic complications, and less likely to engage in early screening than white people (National Diabetes Data Group (U.S.),1995; Nsiah-Kumi, Ortmeier & Brown, 2009). Compared with other ethnic groups, diabetic adults 20 years or older are more likely to be African-American by 77% and Hispanic/Latino Americans by 11%, and diabetic kidney failure is three times more prevalent in American Indians. (Chow et al., 2012). Developing countries, on the other hand, show a high prevalence rate of T2DM among different racial populations, with a prevalence rate of DM 9.2% (39.9 million) of adult-aged people between 18-99 years in the Middle East and North Africa Region (MENA) (IDF, 2017).

Family history of diabetes was significantly associated with T2DM, typically for more than one relative diagnosed with DM (Scott et al., 2013; Harrison et al., 2003). The risk of individuals with both diabetic parents is higher than those with one diabetic parent at 70% and 40%, respectively (Tillil & Köbberling, 1987). Studies found that consanguinity increases the rate of polygenic diseases like T2DM, such as in the Saudi population

(Anokute, 1992). The first-cousin marriage and distant relative marriage rates are the highest among the Saudi population, with 28.4% and 14.6, respectively. Thus, it will not be surprising that those marriage impacts the prevalence of T2DM in Saudi Arabia (El-Hazmi et al., 1995). Regarding perceptions and family history, some studies found that individuals with a family history were more likely to perceive susceptibility and severity of T2DM than those with no family history 54% and 16%, respectively (Gallivan et al., 2009; Merzah, 2014). However, other studies revealed that family history was not significantly associated with perceived susceptibility or severity of T2DM and did not influence the adherence to healthy behaviors (Ferrian, 2011; Amuta et al., 2017).

Hypertension is also high blood pressure at or above 130/80 mm Hg (CDC, 2020). The prevalence rate of hypertension in the United States has recently increased to 45.4% (CDC, 2020). Saudi Arabia also shows a high prevalence rate at 8.9%, increasing among Saudi females (Alsaghah et al., 2019). The association between hypertension and T2DM has been proved in several studies among different ethnic groups (ADA, 2014; Suematsu et al., 1999; Alsaghah et al., 2019). Factors like lack of knowledge about the risk of hypertension and an individual's perception of the disease would increase the risk of hypertension and T2DM (Asiri et al., 2020; Kusuma, 2009). Baig et al. (2015) found that about 7.5% of 610 college students in Saudi Arabia suffered from hypertension.

Hypercholesteremia is a high level of low-density lipoprotein cholesterol (LDL-C). Elevated LDL plays a crucial role in developing chronic diseases such as (i.e. cardiovascular disease, peripheral vascular disease, and stroke), and the risk increases with other chronic diseases such as hypertension and T2DM. Approximately 38% of adults 20 years old and older in the United States suffer from high cholesterol (Virani et al., 2020; Michael, Asuka & Jialal, 2021). The Saudi population, in this regard, has a high prevalence of hypercholesteremia 13.8 %, and hyper-LDL-cholesterolemia 12.85%, with those percentages associated with a low level of knowledge about blood cholesterol management, lifestyle, and diet, as well as genetic factors (Al-Nozha et al., 2008; Batais et al., 2017; Al-Hassan et al., 2018; Alzahrani et al., 2020). High cholesterol levels are caused either by genetics, known as Familial hypercholesteremia, or by other medical conditions such as underactive thyroid gland or by poor lifestyles such as unhealthy diet, low exercise, and smoking (U.S. National Library of Medicine, 2017).

Smoking is the sixth of eight leading causes of death worldwide. Every year, about 5.4 million people are killed from lung cancer, heart diseases, and other illnesses due to tobacco, and the death rate increases to 8 million per year due to tobacco-related diseases (CDC, 2018). Studies found a significant association between smoking and insulin resistance and the development of T2DM in both genders (Arslanian, 2002; Gulli et al., 1992). Tobacco smoke consists of over 4800 chemicals, 69 carcinogens, and other chemicals that are tumor promotors (Sajid et al., 2008).

Additionally, hookah and electronic cigarettes have emerged as similar health risks. Hookah smoking is strongly associated with diabetes, obesity, and dyslipidemia (Soflaei et al., 2018). Recently, waterpipe smoking and electronic cigarettes have emerged as health risks, but at the same time, there is a misconception that they are less harmful than cigarette smoking (Abdulrashid et al., 2018). With the noticeable decline in tobacco use in many developed countries, the percentage of tobacco consumption persists as a trend in low-and-middle-income countries (Drope et al., 2018). Concurrently, high-income countries like Saudi Arabia rank fourth in tobacco consumption (Al Moamary, 2010). A study conducted among various participants from several countries in the Middle East about the habit of smoking waterpipes revealed that Saudi Arabia had the highest waterpipe use (8.5% of respondents, N=65,154) (Khattab et al., 2012). The literature review discovered that the smoking prevalence rate among Saudi adults is higher than in most regional countries (Alotaibi et al., 2019; Fida & Abdelmoneim, 2013; Abd El Kader & Al Ghamdi, 2018).

The prevalence of smoking among the Saudi population was 12.2% (n=10735), with the majority in the college-age of 19 years (+/- 6.5 years), 4.3% reported smoking hookah daily (7.3 of male, 1.3 of female) (Morad-lakeh et al., 2015). About 91% of medical students lack knowledge of smoking-related health risks (Jradi & Al-shehri, 2014). Abdulrashid and his team (2018) found that the frequent use of a water pipe was reported by 39.6% of Saudi women (n=332), where the majority of whom were either students or workers (Abdulrashid et al., 2018).

Being Overweight and Obesity has been significantly associated with T2DM due to its rule in increasing insulin resistance (Wondmkun, 2020). Evidence shows a significant difference between diabetics and non-diabetics in terms of the associated risk factors, including health behaviors such as being overweight or obese 42.3%, high triglycerides (TG) 43.4%, low level of high-density lipoprotein (HDL) 37.3%, and high cholesterol 23.7% (Al Mansour, 2020).

Body mass index (BMI) is the best parameter to measure weight by dividing weight in kilograms by height in squared meters. The World Health Organization (WHO) defines overweight as the BMI range of 25 to 29.9, and obesity is defined as an increased BMI of more than 30. According to the World Health Organization (WHO), almost a quarter of the East Mediterranean region population has diabetes (World Health Organization, 2016). People who suffer from obesity perceived a high level of susceptibility and severity of T2DM (40%) compared to overweight (29%) or not overweight (16%) (Gallivan et al., 2009). A high prevalence rate of obesity and being overweight is one of the public health concerns in SA, which needs an urgent call to assess risk factors for obesity and being overweight and implement prevention programs and policies for youth at local and national levels.

Saudi Arabia is ranked 14th as the most obese in 2020, with a prevalence of 24.7% (Althumiri et al., 2021). The current prevalence of obesity among Saudi students (n=401) was 11% for obesity and 23% for overweight (Makkawy et al., 2021). A study conducted in SA revealed that being overweight among men was 30.7% and among women was 28.4%, while the prevalence rate of obesity was higher among women than men with 23.6% and 14%, respectively (Alqarni, 2016). Additionally, adolescents in SA reported a high prevalence rate of being overweight and obese at 30%; however, the result was limited to females (El Azab et al., 2019). Likewise, Almutairi et al. (2018) found that 20% of the college students (n=1656) in one urbanized city "Riyadh" were overweight, and 11% were obese. A study conducted by Baig et al. (2015) examined the obesity rate among 610 participants in another urbanized city, "Jeddah," and found that 29.8% of the participants were overweight, and 10.7% suffered from moderate obesity, and 7.9% had severe obesity.

Physical Inactivity is an essential factor because the risk of diabetes is positively associated with physical inactivity by 20% (Lee et al., 2012). Chronic diseases and mortality rates will also increase due to insufficient physical activity (Booth et al., 2012). Physical inactivity is a public health issue among younger ages worldwide. According to WHO (2018), the global estimation of physical inactivity was 23% of young adults aged 18 years, and the rate increased in females and high-income countries. Muslim countries have a high prevalence rate of physical inactivity at 32%, especially among women at 35% (Kahan, 2015). For instance,

The current physical activity recommendation for adults between 18 to 64 is 30 minutes of moderate to vigorous physical activity at least five days a week. However, more than 45% of college students in Saudi Arabia (n=278) are not meeting this recommendation (Al-Hassan et al., 2020; Almutairi et al., 2018). In Pakistan, about 48.2% of college students did not meet the recommended physical activity guidelines (Ullah et al., 2021).

According to Al-Hassan et al. (2020), although 278 participants perceived obesity as a severe health issue, and most perceived physical activity to be beneficial in preventing obesity, only 50% of participants reported their susceptibility to be obese in their lifetime. The physical inactivity barriers among college students in Saudi Arabia were reported as time limitations (18.5%), lack of motivation (16.1%), unsuitable weather (7.2%), low income (2.6%), heavy academic assignments, and a limited number of fitness centers (Alkhateeb et al., 2019; Kahalafalla et al., 2017). Saudi female college students had a higher rate of physical inactivity than males (Alzamil et al., 2019; Alhakbany et al., 2018). In contrast, Albawardi, Jradi & Al-Hazzaa, 2016 found that the prevalence of physical inactivity among Saudi women was 52.1%. The limited number of sports centers for females, lack of social support, lack of willpower, lack of knowledge about the benefits of physical activity (Al-Eisa et al., 2016; Al-Hazzaa, 2018), a sweltering climate, culture, and transportation restrictions are the contributing factors to physical inactivity among Saudi females, gender role, family support, general health concerns (Albawardi, Jradi & Al-Hazzaa, 2016; Aljehani et al., 2022).

Poor Dietary Habits

The growing number of junk food restaurants increases people's consumption, especially in the younger population. According to the World Health Organization, poor eating habits could lead to serious health issues such as cardiovascular diseases, obesity, T2DM, and some types of cancers. Recent studies have shown that fast food consumption and fast-food restaurants have dramatically increased in Saudi Arabia (AlFaris et al., 2015; Mandoura et al., 2017). A high prevalence of junk food consumption was reported among adults of both genders (Mandoura et al., 2017). In this regard, Saudi college students have an inadequate adherence to healthy eating habits (Almutairi et al., 2018). One study found that the percentage of college students who reported junk food consumption at least once a day in

SA was 57% of the total sample (n=116), and 43% consumed soda and energy drinks daily (Khabaz et al., 2017).

On the other hand, the college-age group was less likely to consume healthy food. For instance, Al-Otaibi (2014) found that 78% of students consumed less than five servings/day of fruit and vegetable, while 22% consumed equal to or more than five servings/day. In Bahrain, a similar result was found among adolescents: about 27.7% of students have not consumed fruits; females constitute the most percentage of that, 66.5% (Musaiger et al., 2011). Musaiger et al. also found that for about 24% who consumed large potato chips, no difference was observed between gender in the fast-food consumption. A considerable number of participants consumed soft drinks every day, 42.2%. In Musaiger's study, females were more likely to consume sweets, chocolate, and soft drink than males. About two-thirds of Saudi adolescents consume fast food and sweetened drinks more than three times a week (Al-Hazzaa et al., 2012). In contrast, only one study found that college students in Saudi Arabia reported a limited intake of fast food 73.4% and sugary drinks 68.8%; however, this study was done in a private college with a high-income level of participants, which may differ from other public colleges in the same city with different monthly income (Hakim, 2018).

Furthermore, evidence shows that health care providers are role models and counselors for their patients, as they assess and educate patients daily (Tejoyuwono, 2019); therefore, being a nutritional knowledgeable and healthy role model will affect the community. Unfortunately, unhealthy food choices such as potato chips, pizza, sweets, and the lack of skimmed or semi-skimmed milk significantly affect obesity among resident physicians in SA (Alqarni, 2016).

Stress

Several factors increase weight gain. One of these factors among college students is a high-stress level leading to emotional eating. Furthermore, depression symptoms and their associated health conditions are common among college students (Gower, Hand & Crooks, 2008; Pelletier, Lytle & Laska, 2016; Choi, 2020, Cvetovac & Hamar, 2012). The high level of stress leads to unhealthy food choices in some students, such as the consumption of high-calorie food and drinks, including energy and soft drinks, fast food, beverages, and sweets, compared with unstressed participants ($P<0.05$) (Yau & Potenza, 2013; Dahlin, Joneborg & Runeson, 2005; Ahmed et al., 2014; Almogbel et al., 2019). Uncontrolled weight gain leads to obesity, the most significant risk of T2DM among college students (Akbar et al., 2020; Amuta et al., 2016; Amuta, Barry & McKyer, 2015). Studies have revealed a significant and faster weight gain among college students than in the general population. (Vadeboncoeur, Foster, & Townsend, 2016; Villareal et al., 2005).

The prevalence of stress increased among medical students by 53%, and the third year was the most stressful (Rahman et al., 2013; Abdulghani, 2008). Stress levels were higher among medical students than others due to high stressful factors such as social isolation, psychological stress, and the pressure of examinations and which placed their health at risk of weight gain and T2DM (Shrinivasan, Vaz & Sucharita, 2006; Asghar et al., 2019), and irritable bowel syndrome (Qureshi et al., 2016). The prevalence rate of stress among undergraduate students in Saudi Arabia was 28.2 %, with the level of stress reported as mild (17.3%), moderate (49.1%), severe (25%), and highly severe (9%) (Almogbel et al., 2019). No significant difference was found between genders (Rahman et al., 2013). Such findings indicate that the development of college stress management strategies should modify students’ health behavior regarding calorie consumption (Austin et al., 2005; Elshurbjy & Ellulu, 2017).

Health Belief Constructs

Perceived susceptibility is defined as an individual's belief of the likelihood of getting the disease, while perceived severity refers to a person's belief about the seriousness of the disease or condition and its complications (Glanz et al., 2002). Predicting high-risk individuals through the Health Belief Model (HBM) lens, based on their behaviors and characteristics and encouraging healthy behaviors will reduce the disease (Champion & Skinner, 2008). Behavior modification occurs if individuals believe in their risk of a disease and its consequences (Onu & Babatunde (2018). It has been suggested that people with a higher perceived severity become more motivated to take up diabetes self-care behaviors (Mayega et al., 2014; Park et al., 2010). The combination of perceived susceptibility and seriousness results in perceived threats (Stretcher & Rosen-stock, 1997). It was noticed that the perceived threat of diabetes is lower in men, those with a low education level, the elderly, and young people (Kowall et al., 2017, Taradash et al., 2015). Education based on the HBM, including perceived severity and susceptibility, has been significantly associated with health behavior improvement among college students (Maheri, Tol & Sadeghi, 2017).

Moreover, people are more likely to engage in healthy behavior when they believe in the benefit of the new behavior in disease prevention (Strecher et al., 1997). Perceived benefits and perceived barriers are the central constructs affecting individuals' self-care (Mohebi et al., 2013). In a study among college students in Saudi Arabia, although 77% of participants perceived the benefit of fruit and vegetable consumption, they failed to meet their recommended intake (Hakim, 2018). Additionally, studies found that people who perceived the diseases or health issues as a severe condition were more likely to change their behavior than those who just perceived they were at risk of having the diseases (Chen et al., 2019). For instance, a study conducted by Al-Hassan et al. (2020) of 278 college students in Saudi

Arabia found that only 50% of participants perceived they were vulnerable to obesity, while 75.5% of participants perceived obesity as a severe health condition.

Self-efficacy

Self-efficacy is a person's perception of her or his ability to perform or control an action (Bandura, 1977). Self-efficacy is an essential determinant of an individual's health behavior. Although perceived threat in terms of perceived severity and perceived susceptibility have a significant association with behavioral modification (Yokokawa et al., 2016), self-efficacy is the strongest aspect (Richman et al., 2001, Saghafi-Asl, Aliasgharzadeh & Asghari-Jafarabadi, 2020). A higher sense of self-efficacy is significantly associated with healthy food intake, physical activity, and weight loss (Wardle & Steptoe, 2003; Bebeley, Liu & Wu, 2017; Al-Otaibi, 2013; Alemdag, 2018). Additionally, researchers found higher reports of self-efficacy, improved eating habits, calorie label use, and weight loss among college students (Roach et al., 2003; Cha et al., 2014). With a 63.3% prevalence rate, moderate self-efficacy was found as a barrier to physical activity among college students in Saudi Arabia (Gawwad, 2008; Samara et al., 2015).

Knowledge

Knowledge is one of the essential constructs of health behavior modification. It plays a crucial role in disease prevention, helping people assess disease risk and its complications. A high level of knowledge and awareness increases participation in the prevention program; thus, the quality of life and disease prevention increases (Holla et al., 2014; Bani, 2015; Hamoudi et al., 2012). Knowledge is effective in chronic disease prevention such as T2DM, particularly in colleges and high schools. These settings are appropriate for educational and prevention programs such as diabetes awareness interventions (Khan et al., 2012). According to Azinge (2013), a high level of awareness motivates people to practice a healthy lifestyle. However, studies revealed that knowledge alone is insufficient to engage in healthy behavior

(El-Ahmady & El-Wakeel, 2017; Arlinghaus & Johnston, 2018; Feldman & Sills, 2013). For example, a study conducted among Saudi college students found that knowledge alone was not significantly associated with healthy food consumption (Al-Otaibi, 2014).

The overall knowledge regarding diabetes among college students in Saudi Arabia is low to moderate. For example, a study conducted by Gazzaz (2020) revealed that out of 1428 participants, only 186 (13%) had a high level of knowledge, while 569 (39.8%) had a moderate level, and those who had a low level was 673 (47.1%). Gazzaz (2020) also observed that females had a higher level of diabetes knowledge than males regarding diabetes risk factors, signs and symptoms, control and measurement, complications, and overall knowledge scores.

Additionally, there is a lack of consensus regarding the level of knowledge of DM in Saudi college students. Some studies revealed that the level of knowledge about diabetes was high among medical students compared to other majors (Wajid et al., 2018; Hakim, 2018). Whereas other studies found that medical students in Saudi Arabia had insufficient knowledge about the epidemiology of diabetes and the angle of insulin injection, and pointed to improved knowledge of diabetes and its complications among this population as increasing awareness for patients, families, and communities (Alanazi et al., 2018). They also have insufficient information about diabetes's consequences and preventive measures, despite their knowledge of disease diagnosis, treatment, symptoms, and etiological factors, higher than Jordanian students (Khamaiseh & Alshloul, 2019). Al-Mutairi (2018) revealed a significant difference between health major students and non-health majors regarding health-promoting lifestyles. For example, students in health majors were more proactive by discussing health concerns with their health caregivers, and they were more likely to seek guidance and counseling than non-health majors (Almutairi et al., 2018).

Risk Factors for T2DM specific to the Saudi community

In 2010, Saudi Arabia reached the highest number of years lost to disability (YLDs) because of diabetes, which was 8%, compared with ischemic heart disease, which was 0.81% of YLDs, due to the demographic shift in the last 20 years. A sedentary lifestyle has resulted in poor food choices, low physical activity, and increased obesity among Saudis (Majeed et al., 2014; Al-Hazzaa, Abahussain, & Al-Sobayel, 2011; Ng, Zaghloul, & Ali, 2011). As the modernization of society increases, obesity and diabetes increase as well due to unhealthy food, physical inactivity, eating habits, and stress (Alberti et al., 2004; Al-Nozha et al., 2005; Al-Nozha et al., 2007; Horaib et al., 2013).

Other factors connected to the specific context of Saudi Arabia need to be considered to understand the issue entirely. Health beliefs and practices are based on education, generation, and religion, Islam. Although WHO (1984) defined health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity," health differs from culture to culture. For example, in SA, health would be defined based on cultural, traditional, and religious aspects.

Psychosocial factors, culture, and religion are all important factors that influence health behavior and beliefs (Jazieh et al., 2012). The practices of complementary and alternative medicine (CAM) in disease prevention vary from one country to another based on their beliefs. Importantly, traditional medicine in the Arab world has been practiced more than modern medicine. Using herbs and alternative traditional medicine is considered part of the Saudi culture and beliefs and has grown significantly among medical professionals (Al Mansour, 2015). A meta-analysis of 73 studies among the Saudi population revealed that the most common use of CAM practices is herbs 8-76%, honey 14-73%, dietary products 6-82%, cupping 4-45% (Alrowais & Alyousefi, 2017). Spiritual healing and cauterizing have been noticed widely, especially among older people and those with low education (AL-Shehri, 2020). Studies revealed that 15.6% of diabetes patients in Saudi Arabia believed in herbal medicine as a safe treatment, 25.85% believed that the traditional treatments are beneficial, and 30% of patients used it for treating their diabetes (Al Saeedi, et al., 2003).

Additionally, culture influences communities' health (Wasti et al., 2012). Although the way of living in the United States in terms of daily lifestyle is different from the Saudi lifestyle, some Saudi students still stick with their cultural practices, which may contribute to the development of diabetes. For example, a traditional practice that is considered part of the Saudi culture is eating habits, which consists of consuming high-calorie foods such as red meat daily, along with the intake of dates, desserts, and rice dishes which incorporates excessive content material of fat and carbohydrates (Amin, Al-Sultan, & Ali, 2008; Mahfouz et al., 2008).

Another example of the cultural practices specific to Saudi females is that they believe that physical activity should be limited after the delivery of a child, and it is not encouraged during the first 20 days after delivery. *(*Al-Nozha, 2007; Hundt, et al., 2000). In addition to physical limitations, women are treated as patients for 40 days after delivery, and a high calories diet and multiple meals in a day are encouraged postpartum (Abdulallah & Ali, 2007). In addition to these cultural barriers, social habits and weather are also barriers to being physically active (Al-Eisa & Al-Sobayel, 2012). For example, wearing Abaya or hijab restricts women from being physically active outdoors, and there is a lack of motivating health education programs for lifestyle modification (Al-Hazzaa, 2018).

Screening and diagnostic tests for T2DM

The most significant mortality causes of T2DM are ketoacidosis and hypoglycemia, while the highest morbidity is associated with microvascular (i.e., retinopathy, neuropathy, nephropathy) and macrovascular complications, including strokes and coronary artery disease (Higgins, 2013). T2DM complications can be prevented by early screening and treatment for pre-diabetes or diabetes patients (Holman et al., 2008; Diabetes Prevention Program Research Group, 2002). The screening and diagnostic tools of T2DM are already available and useable for diagnosis purposes for pre-diabetes and diabetes (Cox & Edelman, 2009).

The current practical test used in the clinical setting for T2DM diagnosis is fasting plasma glucose (FPG), usually performed in the morning after fasting for at least 8 hours and before breakfast. The average level of FPG is less than 100 mg/dl, and for prediabetes, it is between 100 mg/dl to 125 mg/dl, while the diagnostic level of diabetes is 126 mg/dl or higher (ADA, 2020). Another diagnostic test is the oral glucose tolerance test (OGTT) performed by drinking a glucose drink, and 2 hours later, if the blood sugar level is greater than or equal to 200 mg/dL, it is diabetes, while the average glucose level is less than 140 mg/dL. OGTT can be repeated on another day to confirm the diagnosis (ADA, 2002; Eyth, Basit & Smith, 2019).

The hemoglobin A1c, also known as HbA1c, is another screening tool that measures the average blood sugar level over the past 90 days. The normal A1c value is below 5.7%, the prediabetes range is 5.7% to 6.4%, and the diabetes value range is 6.5% or above. Regular check-ups for A1c are recommended for diabetic patients (Gilstrap, et al., 2019; Eyth & Naik, 2019). The A1c value can be affected by other health conditions such as anemia, hypertriglyceridemia, chronic liver disease, and pregnancy (Malkani & Mordes, 2011). Random plasma glucose (RPG) test is an easy and quick test that can be done any time of the day and is usually used to check the blood sugar of diabetic patients who have severe symptoms, The diagnostic level of diabetes is 200 mg/dl or higher (ADA, 2020).

Treatment for T2DM

Diabetic patients are usually treated based on the stage of diabetes; however, self-management, increased physical activity, control of the glucose level, and healthy food choices are all part of the treatment plan for pre-diabetics, diabetics, or high-risk individuals. Moderate physical activity and diet have significantly reduced the mortality rate of diabetes in the last two decades and will remain the first steps to treating diabetes in the future, along with pharmacological treatment for severe cases (Joslin, 1923; Orwell, 2018). Metformin is an oral hypoglycemic agent (OHL) used in diabetes treatment to enhance insulin resistance resulting in reduced hepatic glycogenesis and glycogenolysis (Rodbard et al., 2007; Orwell, 2018). The second option for diabetic patients is meglitinide. It enhances insulin secretion, which minimizes the adverse effects of hypoglycemia (Quianzon & Cheikh, 2012). Another classification of diabetes pharmacology treatment is thiazolidinediones (TZDs) including Pioglitazone, which helps reduce hepatic glucose production and enhances insulin sensitivity in the muscles' receptors (Groop et al., 1991). GLP-1 (i.e., exenatide, dulaglutide, lixisenatide, albiglutide, semaglutide), saxagliptin, linagliptin, etc. vildagliptin and alogliptin, and empagliflozin show a better outcome for diabetic patients (Holst, 2006; Orwell, 2018; Quianzon & Cheikh, 2012). Despite the wide use of those drugs as a second-line treatment due to the positive outcome for people with diabetes, most of them lead to adverse side effects on cardiovascular health (Hausenloy & Yellon, 2008; IDF, 2017; Orwell, 2018).

With all of this in mind, understanding diabetes is considered a critical aspect of growing the possibilities of participation in any disease prevention and management program. It is likewise considered a high-quality indicator for managing the disease. Lifestyle changes and alterations can decrease the prevalence of the disease, especially in high-risk adults with impaired glucose tolerance (ADA, 2014).

Prevention of T2DM

In the United States, several prevention programs have been established to delay or prevent the onset of T2DM, such as the National Diabetes Prevention Program (DPP), created in 2010 to collaborate between public and private organizations to produce effective group-based lifestyle interventions. These evidence-based interventions have been implemented in communities through an organization such as the YMCA (CDC, 2018). The long-and short-term effect of DPP in terms of lifestyle modifications in the delay or prevention of T2DM has been shown in many studies (Ratner, 2006; Knowler et al., 2009; Joiner, Nam & Whittemore, 2017; Hamman et al., 2006; Annesi & Johnson, 2020).

Intervention studies on the Saudi population related to T2DM prevention were not built on theory, and all of them were conducted in clinical settings among diabetics or prediabetics 40 years or older, and none targeted college students. However, most of those interventions showed the significant effect of intervention programs in delaying or preventing the progression of T2DM, and these studies conducted programs on dietary restriction, physical activities, and weight reduction (Al-Hamdan et al., 2019; Wani et al., 2020; Amer et al., 2020). For instance, a recent 18- month intervention on prediabetics aiming at determining the efficacy of a lifestyle modification program on prediabetes reversal in SA has revealed that the cumulative incidence of prediabetes reversal in the interventional group was (52.1%), which is higher than the control group (30.6%; $p = 0.02$) (Amer et al., 2020).

Additionally, diabetes educational programs show effectiveness when adapted to the target population's culture and religion (Osuna et al., 2011; Haas et al., 2012). Based on that, Al-Bannay and her colleagues (2015) conducted a diabetic education program based on international standards among Saudi women. There was a significant improvement in lifestyle, blood glucose control, life satisfaction, and a high level of physical activity with 6-minute walking. Another study also shows the positive impact of health education in changing Saudi behavior (Midhet & Sharaf, 2011). Although several education programs have been conducted on diabetics among the Saudi population, very few of them targeted non-diabetics or prediabetics, so the majority of education programs were conducted on diabetic patients (Mahmoud et al., 2018; Al Hayek et al., 2013; Al-Wahbi, 2010; Bahammam, 2015). Therefore, there is a gap in the T2DM prevention programs targeting high-risk or non-diabetic individuals, including college students.

Other preventive measures

The most practical guidelines for T2DM prevention among people with impaired glucose intolerance are lifestyle modification such as weight management, increased physical activity, and healthy food choices (Nice, 2012; American Diabetes Association, 2017). In addition, other modifiable factors are smoking cessation and controlling psychosocial factors (e.g., stress, anxiety, and depression) (Issaka et al., 2018). The following paragraphs highlight key findings from existing studies on these protective factors related to T2DM.

Physical Activity (PA) is one of the most protective factors in T2DM prevention as insulin resistance improves. Recommendations have been introduced by the CDC (2019) to prevent diabetes among high-risk groups with the main objectives of assessment of the individual's needs, setting a goal of weight reduction, planning for healthier food choices, and performing moderate exercise for 30 minutes of moderate to vigorous aerobic activities such as swimming, cycling, running, brisk walking for 5 days/week. Studies found that 150 minutes of walking reduces DM by 27% (Jeon et al., 2007).

A healthy diet is considered another vital factor in T2DM prevention. *Healthy People 2020* has created nutritional objectives to reduce the risk of chronic diseases. Those objectives recommend increasing the intake of whole grains, fruits, vegetables, low fat or fat-free milk product, limiting the intake of saturated and trans fats cholesterol, limit consumption of sugar, salt, and alcohol. It is also recommended to eat a low-calorie diet, as the evidence shows that certain types of food components may increase the risk of T2DM. For example, diabetes can be increased by consuming red meat, and the risk increases up to 26% for those consuming more than one sugary beverage daily (Ley et al., 2014). Conversely, a low-calorie diet, including a Mediterranean diet such as whole grains, high fiber, fruit, and vegetables, reduces the risk of diabetes and obesity (Wang et al., 2016).

Weight reduction is another effective strategy in T2DM prevention. Losing 5% to 7% of body weight and increasing physical activities are recommended. Evidence shows that weight loss and lifestyle changes reduced overall diabetes incidences by 58% over three years; the incidences decreased to 25% after 22 years (ADA, 2020).

Smoking cessation would also help reduce the risk of the development of T2DM. Smoking enhances the development of T2DM by increasing insulin resistance. According to the U.S. Department of Health and Human Services DHHS (2014), smokers are 30% to 40% more likely to have T2DM than non-smokers, and controlling their diabetes would be challenging among smokers. A longitudinal study of 50,000 Chinese men who smoke more than 20 cigarettes/day revealed that the ratio of the diabetes incidence was 1.25 (95% CI: 1, 1.56), and the ratio increased to 1.28 among smokers who smoke more than 40 cigarettes/day compared to nonsmokers (Shi et al., 2013). Therefore, smoking cessation is essential in reducing the risk of T2DM.

Stress management is one of the public health strategies in diabetes prevention and management. Stress management interventions based on social cognitive theory effectively increase coping self-efficacy, and perceived social support, reduce stress, and improve HbA1C among diabetic patients (Zamani-Alavijeh et al., 2018). Thus, stress management is suggested as part of a lifestyle change intervention, especially for individuals exposed to high stressors.

Perception and knowledge are also important. People with a higher perceived severity become more motivated to undertake diabetes self-care behavior (Tawfik, 2017). High levels of knowledge and awareness also increase participation in screening and prevention programs (Tawfik, 2017).

Social and environmental determinants may contribute to obesity, which enhances the risk of diabetes. It is crucial to improve the environmental factors to encourage healthy behavior and reduce the incidence of T2DM. For example, the health promotion services provided by YMCA in the United States, such as weight loss, wellness, and diabetes prevention programs, are some of the United States' environmental supports that encourage adherence to diabetes prevention behaviors. In 2016-2017, a national study conducted on 50,912 non-diabetic participants in the United States found that engaging in diabetes prevention behavior or benefiting from health promotion programs was reported by 33.5% to 75.2% of those who had elevated American Diabetes Association (ADA) risk scores (>5), and 35% to 75.8% of those who diagnosed with prediabetes (Ali et al., 2019). The study, however, noted that there is a gap in receiving health promotion services, and there is a need to increase referral and advice by a health care professional to benefit from these services in U.S. adults (Ali et al., 2019).

Additionally, it has been found that a free public gym, such as one in a public area, encourages several physical activities, including walking (19%) and vigorous activity (16%) (Cohen et al., 2007). One further environmental support to encourage people to perform healthy behavior is offering healthy food choices in the public spaces, workplaces, or educational initiations is an important protective factor. Healthy snacks in vending machines could help encourage healthy food choices. For example, the Health Star Rating (HSR) is voluntary front-of-package labeling applied in Australia since 2014 to decrease obesity. A study found that from 2014 to 2017 when food with HSR labels was placed in university vending machines, there was a significant increase in the consumption of healthy snacks from 7% to 14% and beverages from 38% to 44% (Shi, Grech & Allman-Farinelli, 2018). In addition to healthy food choices, offering space for a fitness room, sidewalks, gyms, or a membership at a local gym to encourage physical activity would help promote a healthy environment.

Health Policy in Saudi Arabia

In 2016, Saudi Arabia established health objectives under 2030 that focused on non-communicable diseases with the development of the environment, health education, policies, and women's opportunities. The Saudi Ministry of Health's goal is based on the public health approach to prevention, including preventing the diseases from occurring, treating those who already have an illness, preventing any further complications, and rehabilitation. About 60% of health services such as health education and promotion, early detection, consultation, and treatment are accessible for Saudis and non-Saudis as provided by the MOH (Sebai, Milaat & Al-Zulaibani, 2001). The MOH has established 20 specialized centers for diabetes treatment, and they also have a ten-year national executive plan (2010-2020) for diabetes control and prevention (MOH, 2013). Centers have established programs for non-communicable diseases (NCDs), including healthy food habits, prevention of diabetes, and physical activity (Al Busaidi, Shanmugam & Manoharan, 2019). The Saudi MOH and WHO have established in 2006-2011 that recommended the importance of promoting a healthy lifestyle among young people. Later, the MOH prioritized promoting a healthy lifestyle based on Saudi values and practices. MOH also had another collaboration with WHO's Eastern Mediterranean Regional Office (EMRO) in 2012, and they organized a conference with the recommendations of the conference being to combat diabetes at the regional level (MOH, 2013)

Under the Saudi vision 2030, health-related policies have been implemented. These include tobacco prohibition in public areas, tobacco taxation to over 15% in the last three years, seat belt regulations, and many more, along with current policies to tackle diabetes and obesity, such as applying to calories label policy to be mandatory to appear on menus for all restaurants and café in January 2019 (Gillett, 2019). However, most policies have not been evaluated yet (Alharbi, Alotaibi & de Lusignan, 2016), and health education promotion programs have still not been proven effective. Furthermore, diabetes prevalence remains high among the Saudi population.

Several reasons for the steady increase of diabetes in Saudi Arabia include the lack of health education and promotion of diabetes, as most education is conducted by either physicians or nurses in the primary care centers instead of diabetes educators (Badran & Laher, 2012; Jradi, Zaidan, & Al Shehri, 2013). The majority of nurses who provide health education are non-Arabic speakers. Thus, they could not communicate effectively with Saudi patients or be Arabic nurses, but they have not had training in public health or health promotion (Jradi et al., 2013). The Saudi health care system lacks advocacy for diabetes prevention (Alharbi, Alotaibi & de Lusignan, 2016). Moreover, until now, there are no clear policies addressed for the non-diabetic population. It is also difficult to assess the impact of the policies and programs that were planned and implemented since there are unclear indicators of diabetes control in Saudi Arabia. Therefore, policymakers must set up their efforts to prevent diabetes (Al Busaidi et al., 2019). In addition, the researcher needs to follow up and evaluate the outcome for many years after the interventions.

Background of the Saudi community in the U.S.

The current population of Saudi Arabia in 2021 is 35,473,686. The median age is 31.8 years, 61.93 percent are male, and 38 percent are female (Worldometer, 2021). The annual growth rate is 1.59 to 2 percent yearly (World population review, 2021). Arabic is the country's official language and is spoken by almost all the population. English is considered the unofficial second language, and the use of English has increased since the launch of scholarships abroad. 15,000 Saudi students and their families live in the U.S. (SACM, 2022).

All Saudi students must have health insurance, which is entirely paid for by the Cultural Mission of Saudi Arabia to the U.S. The insurance covers surgeries, medical emergencies, child delivery, counseling, and health education programs. In addition, Saudis come to the United States for many reasons, not only for academics but also for treatment and leisure.

The gap in the Literature

In the literature and preventive viewpoint, no study has examined the influence of personal health beliefs and environmental factors on physical activity and dietary behavior among Saudi college students in the United States. The majority of the T2DM studies conducted in the Saudi community were either descriptive or prevention programs among patients with T2DM but not in the non-diabetic population (Mahmoud et al., 2018; Dinar et al., 2019; Mohammad & Khresheh, 2018; Almeman, 2019; Alzeidan et al., 2019; Alanzi et al., 2018; Alabdulbaqi, 2019). These studies suggested the urgent implementation of national and local assessment, screening, education, and prevention programs targeting schools, college students, and high-risk groups. Addressing risk factors of T2DM among all age groups and gender was also recommended for further studies (Alqurashi, Aljabri, & Bokhari, 2011). Most of the studies that have been done in Saudi Arabia focused on the secondary and tertiary levels of the prevention or primary level to control other health conditions related to diabetes among T2DM patients (Al-Shahrani et al., 2012). Since age is one of the non-modifiable factors of T2DM, several studies conducted in the Saudi population targeted older ages 45 and older (Al-Daghri et al., 2019; Mohamed, Mahfouz & Badr, 2020). It is noted that only a few of those studies hypothesized to achieve critical outcomes such as screening, delaying, or preventing the onset of T2DM either in pre-diabetes (Abdelrahman et al., 2018; Amer et al., 2020; Wani et al., 2020; Alateeq et al., 2020; Aldossari et al., 2018) or in non-diabetics (Al-Daghri et al., 2011).

There is an under-recognition of the needs of the over-18 generation in prevention and T2DM assessment programs (Kutbi et al., 2018; Al-Qahtani, 2016; Raza et al., 2010). Limited studies aimed to assess risk factors of T2DM among young male adults and college students (Issa, 2015; Mirghan & Saleh, 2020) and female college students of younger ages (Al-Mutairi et al., 2018; Al-Zahrani et al., 2019; Al-Rethaiaa et al., 2010). A few studies assessed the psychological factors such as knowledge, belief, and perception of the risk factors of T2DM (Rajab et al., 2012; Aljoudi & Taha, 2009). However, most of those studies were unable to address all risk factors related to a healthy lifestyle or unable to maintain healthy behaviors for the long term.

Additionally, there were contrasts between studies' findings regarding the general knowledge of diabetes among the Saudi population. It seems that the educational level affects the knowledge about diabetes; however, studies conducted among college students in Saudi Arabia so far have targeted college students with health majors.

The literature on diabetes among the Saudi population has not yet gained much attention regarding HBM as a theoretical framework to examine the relationship between individuals' beliefs and health behavior. Only three studies have examined such a relationship (Alatawi et al., 2015; Al-Mutairi et al., 2015; Albargawi, 2017). The first study was a correlational study design used to examine the relationship between HBM and medication adherence in diabetic patients (Alatawi et al., 2015). The second study examined the relationship between health beliefs and adherence to self-care activities in managing T2DM among individuals diagnosed with T2DM in Saudi Arabia (Albargawi, 2017). The third study was the only one that assessed the perception level based on HBM among nondiabetic school students in Saudi Arabia (Al-Mutairi et al., 2015).

In the Alatawi et al. (2015) study, the HBM was used to predict medication-taking behavior among 220 patients with T2DM in Saudi Arabia. Participants were recruited from an outpatient pharmacy using convenience sampling. The result showed that about 44% of participants perceived T2DM as a severe disease, while 39% reported their susceptibility to risk for developing complications. Most participants reported the perceived benefits of diabetes medication (70%), and self-efficacy for medication adherence was also reported by most of them (60%). Perceived barriers to medication adherence were reported as work, travel, and forgetting to take it; however, the authors did not provide total scores for the perceived barriers (Alatawi et al., 2015).

Albargawi (2017) used HBM to examine the relationship between health beliefs and adherence to self-care activities to manage diabetes among patients with T2DM in Saudi Arabia. 202 Saudi adults were recruited from diabetes clinics in Riyadh, SA. The results of the study found that the majority of participants reported low levels of self-efficacy toward regular exercise (76%), controlling their blood glucose (56%), and controlling their weight (55%); however, participants who perceived there to benefit from healthy behaviors through diet were 95%, exercise 92%, medication 79%, and routine medical visits 97% (Albargawi, 2017). Perceived barriers were reported as work (58%), leisure activities (53%), difficulty in following their diet in public places (47%), and 35% of participants reported an uncomfortable feeling when managing their diabetes in public (Albargawi, 2017). Most participants (89%) reported high levels of perceived severity of the disease if not controlled, and 95% reported that uncontrolled diabetes leads to adverse outcomes in the future. The study also showed a significant association between perceived family and friends' support and adherence to self-care activities; 80% of the participants who received support from family or friends were able to follow their diet, adhere to their medication (84%), exercise (67%), foot self-care (70%), control their feelings about T2DM (81%), and control their blood sugar (82%).

Al- Mutairi et al. (2015) used the HBM as the theoretical framework for the non-diabetic adolescent population. Participants were recruited from two private and two public schools in Riyadh City (N= 426; Saudi students= 371 and non-Saudi students= 55) and were asked to complete a questionnaire. Survey questions assessed students' perception of severity, susceptibility, benefits, barriers, self-efficacy, and diabetes knowledge. The study's findings showed that the overall awareness of diabetes was high, especially among females, while males engaged in physical activities more often (Al- Mutairi et al., 2015). The study also revealed that the perceived susceptibility and severity of T2DM were low for both genders at 27% and 29%, respectively. On the other hand, the perceived benefit of a healthy lifestyle to prevent diabetes was high at 91%, and a moderate level of barriers to a healthy lifestyle was reported, including lack of time to exercise (46.5%), hot weather (43%), limited choices of healthy food (35%), and unpleasant taste of low-calorie food (46.2%). The majority of students had a moderate to a high level of self-efficacy in maintaining a healthy lifestyle, such as avoiding smoking (94%), regular exercise (50%), consumption of low fat and low sugar meals (52% and 57.5 %, respectively) (Al- Mutairi et al., 2015). Al- Mutairi et al. (2015) emphasized the need for adolescents' awareness about the primary prevention of T2DM, and future research using HBM was also recommended. Therefore, the proposed study's result may fill the literature gaps.

In the outcomes from the context of the Saudi culture literature review that used HBM as a framework, T2DM behavioral outcomes such as physical activity, dietary habits, and environmental factors were not assessed. Additionally, the influence of other factors such as BMI, majors, stress, and environment on the adherence to healthy behaviors, which were found to be essential factors that influence health perception and adherence to T2DM prevention behaviors, were not examined (Gallivan et al., 2009; Merzah, 2014). Therefore, this study aims to fill the gap in the literature and understand factors related to health beliefs and health behaviors and the association between them.

Conceptual Framework

HBM was developed in the 1950s by a group of U.S. Public Health Services psychologists who wanted to clarify the reasons behind encouraging and discouraging people from participating in detection and disease prevention programs; for example, why preventive health services were unsuccessful (Hayden, 2009). Later, researchers expanded the model and concluded six primary constructs in the theory, which had been used to influence people's decisions about whether to take action by screening, preventing, and controlling the disease (Glanz et al., 2002).

The expanded version was initially conceived to expect preventive health behaviors. However, with later adaptations, it has additionally been used to expect the behavior of humans with acute and chronic illnesses. HBM is known as a value-expectancy theory that includes several concepts such as the individual's value of the outcome, the expectation that action can decrease threat, the belief of susceptibility and severity to a condition or disease, the perception of the benefit and barriers of action in reducing a threat (Glanz et al., 2002). The model has added more constructs, including self-efficacy, cues to action, and motivation factors (Champion & Skinner, 2008). The critical concepts of HBM are as follows. **Perceived susceptibility**: one's perception of the chances of acquiring an illness or disease. **Perceived severity**: one's perception of a condition's seriousness and its medical, clinical and social consequences. **Perceived benefits**: one's confidence in the effectiveness of the behavior to reduce threads to the health condition. **Perceived barriers:** one's perception of negative sequences for taking action. **Cues to action**: factors that motivate or remind one to engage in healthy behavior. **Self-efficacy:** the ability to take action and perception that successfully execute the behavior will produce the desired outcome (Gilbert, Sawyer& McNeill, 2011). Regarding the theory generalizability, HBM, one of the most widely used health behavior theories (Glanz et al., 2002), is the origin of systematic and theory-based research in health behavior.

HBM has been employed in various public health settings over the years, and the model has also been used to generate testable hypotheses in various settings. Adequacy is one of the strengths of the HBM. It includes the basic constructs that focus mainly on health determinants that help predict and examine people's behavior; therefore, it is most suitable for addressing problem behaviors with health consequences (e.g., unhealthy eating and physical inactivity). Studies that used HBM found that some of HBM's concepts were powerful in predicting human behavior. For example, one study showed that self-efficacy and perceived susceptibility are strongly associated with healthy eating behavior (Orji, Vassileva & Mandryk, 2012). Another study found that perceived threat, self-efficacy, and cues to action are the strongest predictors of health behavior related to weight reduction (Park, 2011). A meta-analysis of 18 studies also showed that perceived benefits and barriers were powerful predictors predicting people's behavior (Carpenter, 2010).

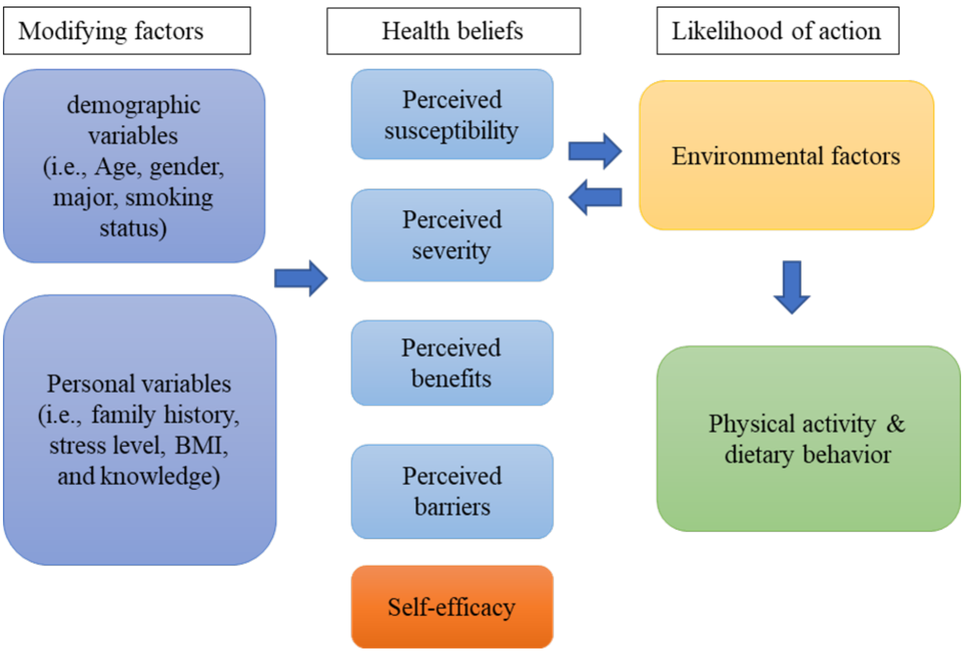
Countless research has used the Health Belief Model to explain and predict health-related behaviors in several areas, including communicable and non-communicable diseases. For example, the model was used in Saudi Arabia to assess Saudi women's beliefs and behavior regarding cervical cancer screening (Aldohaian, Alshammari & Arafah, 2019). Recently it has been used to test the effect of an educational intervention on nursing students' awareness and health beliefs about the COVID-19 outbreak at Najran University (Elgzar et al., 2020).

Additionally, the model was used on diabetic and non-diabetic populations in descriptive, correlational, and intervention studies. For example, it has been used to test factors affecting patient retention in diabetes-related pharmaceutical care services (Pinto et al., 2006) and adherence to medication taking and self-activities among patients with T2DM (Alatawi et al., 2015; Albargawi, 2017). It was also used to examine the effectiveness of a self-management promotion educational program among diabetic patients based on the health belief model (Jalilian et al., 2014). As for the nondiabetic population, the model was used to predict T2DM risk factors and explore its influence on an individual's perception and behavior among a non-diabetic group (Ferrian, 2011; Merzah, 2014; Al- Mutairi et al., 2015). It also was used in health education on nutritional behaviors in female students (Vahedian-Shahroodi et al., 2019), improving diet quality among adolescents (Keshani et al., 2019), and the assessment of the testicular self-examination knowledge among health science students (Ustundag, 2019).

Modified Health Belief Model

The Health Belief Model has been modified by adding environmental factors instead of cues to action and adding other modifying factors such as BMI, family history, knowledge, and stress to fill the literature gap and reflect the purpose of the current study. The original HBM represented the cues to action as factors that motivate or remind one to engage in healthy behavior, internal or external factors (Hayden, 2009). Findings from the literature review suggested an association between environment and behavior (Shi et al., 2018; Gao et al., 2019; Belon et al., 2016). In this study, the cues to action represent environmental factors such as the availability of free gyms and health promotion services provided by the YMCA, such as weight loss, wellness, and diabetes prevention programs.

Figure 1. Modified Health Belief Model (HBM)



Hochbaum et al. (1952). Health belief model. The United States Public Health Service.

Chapter Summary

A literature review revealed the epidemiological studies for T2DM and its associated factors globally and in Saudi Arabia. The prevalence of diabetes has increased rapidly, and it has been ranked as a top 10 cause of death in the world and Saudi Arabia. According to the literature review, there is a lack of research specific to understanding the influence of health beliefs and other T2DM predictors on physical activity and dietary behavior among the Saudi population in general and Saudi international students in the United States. Studies conducted among the Saudi population showed that some factors related to the lifestyle and culture of the Saudi population play a crucial role in developing T2DM. In addition to urbanization, a sedentary lifestyle and traditional habits related to the Saudi population contribute to the risk of T2DM. The level of knowledge of T2DM among Saudi college students varies. The major risk factors based on most studies are physical inactivity, dietary habits, overweight, and obesity; however, little is known about the environmental factors, which may also be considered a risk factor that impacts physical activity and dietary behavior.

Chapter 3

Methodology

Introduction

This chapter describes the study's research methods, including design, research questions, hypotheses, data collection, data analysis, and data management. The chapter will also cover the questionnaire used in the data collection and its validity and reliability. This correlational study examines the influence of health beliefs and other risk factors on behavioral outcomes among Saudi college students living in the United States.

Methods

Design

Most of the literature reviewed in chapter two discussed the relationship between health beliefs and health behavior. A cross-sectional study helps describe the features of a population and assess health needs and determinants of health in a defined population at a single point in time (Wang & Cheng, 2020). The advantage of using a correlational design is that it facilitates the prediction of the association between the dependent (Y) and independent variables (X) (Kraemer, 2006). Accordingly, a correlational cross-sectional design was used for this dissertation, which is the most appropriate design to examine the influence of health beliefs and other risk factors on physical activity and dietary behavior among Saudi students in the United States.

Research questions/Hypotheses

A modified version of the Health Belief Model was used as a theoretical framework to answer the following research questions:

1- What is the association between students' risk factors (i.e., age, gender, family history, major, level of stress, BMI, knowledge, and environmental variables) and physical activity and dietary habits in Saudi Arabian university college students living in the United States?

Hypotheses A:

Null Hypotheses: There is no association between students’ risk factors and physical activity.

Alternative Hypotheses: Risk factors are significantly associated with students' physical activity.

Hypotheses B:

Null Hypotheses: There is no association between students’ risk factors and dietary habits.

Alternative Hypotheses: Risk factors are significantly associated with students’ dietary habits.

2- Is there an association between health beliefs (i.e., perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and self-efficacy) and physical activity and dietary habits among the selected population?

Hypotheses 1a:

Null Hypotheses: There is no association between students’ perceived susceptibility, severity, benefits, self-efficacy, and physical activity.

Alternative Hypotheses: The greater the students’ perceived susceptibility, severity, benefits, and self-efficacy toward T2DM, the more likely they are to follow the recommended physical activity.

Hypotheses 1b:

Null Hypotheses: There is no association between students’ perceived susceptibility, severity, benefits, self-efficacy, and dietary habits.

Alternative Hypotheses: The greater the students’ perceived susceptibility, severity, benefits, and self-efficacy toward T2DM, the more likely they are to eat healthily.

Hypotheses 2a:

Null Hypotheses: There is no association between students' perceived barriers and physical activity.

Alternative Hypotheses: The lower the barriers students report, the more likely they are to follow the recommended physical activity.

Hypotheses 2b:

Null Hypotheses: There is no association between students' perceived barriers and dietary habits.

Alternative Hypotheses: The lower the barriers students report, the more likely they are to eat healthily.

Sample size

According to Bujang et al. (2018), there are guidelines for determining the sample size for logistic regression. The following formula is used:

$n = 100 + 50(i)$, where *I* refer to the number of independent variables in the final model. Thus, the total sample size needed is 500 participants; however, 300 participants would also be acceptable (Bujang et al., 2018). According to Krejcie and Morgan (1970), the minimum sample size needed to represent a total population of 15,000 is 375 participants. Thus, 410 participants for this dissertation adequately represent the total population.

Participants

A non-random convenience sample of Saudi international students living in the United States was recruited for this dissertation. The inclusion criteria for participation were: (a) Saudi nationality; (b) age 18 and older; (c) any majors and degrees (d) studying at United States Universities or English Language Institutes. Since most Saudi students who come to the United States enroll in English Language Institutions as a first step until they achieve the university requirements, they must participate in the study. Those under 18 years old and non-students were excluded from the study.

Data collection

After the IRB approval from Kent State University, the self-report questionnaires were sent to participants via an online survey platform. The survey was distributed through social media such as WhatsApp and Twitter once every two weeks for a month. Using the most popular social media among Saudi students living in the U.S. facilitated the survey distribution to a more significant number of participants through Saudi organizational groups. An explanatory message was written to ask group members to fill out the online survey, and it also was forwarded to students living in the United States. Anyone who participated in the pilot study was asked not to complete the survey. Several questions were created by the principal investigator (PI) (e.g., Are you an international student in the United States? and What is your age in years?) to create the inclusion criteria. Participants who did not meet the inclusion criteria were excluded from the study.

Participants were asked to complete a survey with four scales and questions related to T2DM risk factors and behavioral outcomes. The first scale was the knowledge scale created by Garcia et al. (2001). The scale was modified and reduced to 8 questions with two primary subscales. Each subscale consisted of 4 questions. The first subscale was about medical knowledge (i.e., items # 1,2,3&4), and the second was about signs and symptoms and dietary knowledge (i.e., items #5,6,7&8). Participants were asked to select one of the choices based on their knowledge of T2DM. Responses were True, False, and Don't know.

The second scale consisted of 24 questions that used health belief constructs (i.e., perceived susceptibility, perceived severity, perceived barriers, and perceived benefits) (Tovar et al., 2012). The Health Belief scale consisted of 24 items in four subscales, i.e., perceived susceptibility, severity, benefits, and barriers. These items consisted of a six-point

Likert scale response format where 1 = “strongly disagree”, 2 = “ disagree”, 3 = “slightly disagree”, 4 = “slightly agree”, 5 = “agree”, 6 = “strongly agree”. Participants were asked to indicate the extent to which they disagree or agree with each statement. Likewise, the third scale included 10 questions that assess perceived self-efficacy (Schwarzer & Renner, 2009). Self-efficacy consisted of two main subscales (i.e., the first one to measure the self-efficacy related to dietary habits and physical activity). Responses of the self-efficacy scale had six-point Likert scale where 1 = “strongly disagree”, 2 = “ disagree”, 3 = “slightly disagree”, 4 = “slightly agree”, 5 = “agree”, 6 = “strongly agree”. Participants were asked about their perceptions of healthy foods and physical activity barriers. After reading statements, they had to indicate the extent to which they disagree or agree with each statement.

The fourth one was also ten questions created to assess the level of perceived stress scale (PSS) for measuring the perception of stress by Cohen (1994). The scales were modified to be more applicable to the Saudi population's characteristics and culture and answer the research questions. The Perceived Stress Scale (PSS) included ten items to assess participants' feelings and thoughts during the last month. Participants were asked to indicate how often they felt or thought a certain way in each case. A numerical value was assigned for the responses (i.e., Never = 0, Almost Never= 1, Sometimes= 2, Fairly Often= 3, Very Often= 4).

Additionally, T2DM risk factors were measured by several questions developed by the PI, including participants' age, gender, status in U.S universities or English language institute, major/specialization, BMI, family history of T2DM, smoking status, and current diagnosis of prediabetes, T2DM, or hypertension. All risk factor variables are categorical except for age and BMI, which are continuous. Participants' BMI was calculated based on the BMI formula (i.e., weight (kg)/ height (cm)/ height (cm)x 10,000). On the other hand, age was collected as continuous data. Participants entered their age counted in years, which was collected as a continuous variable. Age was categorized into three groups 18 to 29 years, 30 to 39 years, and 40 years or older. For analytical purposes, age was coded into a multiple categorical variable with values "1" for group ages 18 to 29 years, "2" for 30 to 39 years, and "3" for 40 years or older. After checking the outliers, any participants less than 18 were excluded from the study to meet the inclusion criteria.

The binary variables were gender, major, family history, and current diagnosis of prediabetes, T2DM, or hypertension (i.e., scores 0 if the response is "No" and 1 if the response is "Yes"). Smoking status was categorized into 1 if the response was "Never Smoked," 2 if the response was "Former Smoker," and 3 if the response was "Current Smoker." Environmental factors were measured by two questions created by the PI, including whether participants benefitted from the health education and promotion programs provided in the United States, such as YMCA, and whether they used the gym at universities or public areas. Responses were coded as "0" for No and "1" for Yes.

In terms of the outcome variables (i.e., dietary behavior and physical activity), short validated dietary assessment questions were adopted from an existing food frequency questionnaire (Al-Hazzaa et al., 2013; Musaiger et al., 2011). Questions assessed participants' weekly food choices, including consumption of fruit, vegetables/salad, fast food, potato chips, and sweetened and energy drinks. Participants were asked to select one choice of answers, ranging from zero intake (never), 1 per week, 2 per week, 3 per week, and more than 4 per week. Furthermore, the PI created two questions about physical activity to measure the participants' physical activity, including How many days/week do you exercise? Participants were asked to select one choice of 0 never, 1 day/week, 2 days/week, 3 days/week, 4 days/week, 5 days/week, 6 days/week, or 7 days/week. Another question was created about the average minutes spent in physical activity per day for those who responded that they exercised one or more days/week.

Table 1

Operational Definitions of Variables

Variable Type	Variable	Operational definitions	Measure Type
Predictor	Age	Age in years	Ratio (continuous)
Predictor	Gender	The biological aspects: 1= Male 2= Female.	Categorical (nominal)
Predictor	Major	Majors/Specializations classified into: 1= Health-related majors 2= Not health-related	Categorical (nominal)
Predictor	Smoking status	Current smoking status: 1= Never Smoked 2= Former Smoker 3= Current Smoker.	Categorical (nominal)
Predictor	Family history	Any immediate relatives (parents, grandparents, siblings) with T2DM.	Categorical (nominal)
Predictor	Knowledge	The level of diabetes knowledge, including medical knowledge, dietary knowledge, and signs & symptoms of T2DM.	Categorical (nominal)
Predictor	Stress	The stress level is based on the perceived stress scale (PSS), which is categorized into three levels based on the scale scoring for the data interpretation. 1= low stress (0-13) 2= moderate stress (14-26) 3= high stress (27-40).	Categorical (ordinal)
Predictor	BMI	hight in centimetres and weight in Kilograms using the BMI formula [weight (kg)/ height (cm)/ height (cm)x 10,000].	Ratio (continuous)
Predictor	Health beliefs	Level of perception (i.e., Perceived susceptibility, Perceived severity, Perceived benefits, Perceived barriers and self-efficacy) categorized into three levels based on the percentiles for the data interpretation.	Continuous
Predictor	Environmental factors	Assessment of health promotion services' benefits by YMCA and the use of the gym in the universities or public areas. (composite variable calculated for both questions).	Categorical (nominal)
Outcome	Physical activity	The number of physical activity in minutes per week. The recommended physical activity is 150 min/week or higher. PA is categorized into physically active and inactive.	Ratio (continuous)
Outcome	Dietary habits	Assessment of the dietary habits, including the number of consuming healthy food (e.g., fruit and vegetables) and unhealthy food (e.g., presweetened drinks, fast food, and sugary snacks) per week. The composite scores of responses were calculated and categorized into healthy and unhealthy	Ratio (continuous)

Data analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics were used to explore the demographic data, including frequencies, means, and standard deviations.

Logistic regression aims to test a relationship between multiple predictors and a binary outcome (Stoltzfus, 2011). The outcome variables were collected as a continuous variables and were later categorized into dichotomous data; thus, logistic regression was the appropriate test to answer the research questions. Logistic regression was used to assess the impact of T2DM risk factors on physical activity and dietary behavior and to examine the association between students' health beliefs about T2DM and their physical activity and dietary habits.

Logistic Regression Assumptions:

The statistical assumptions of logistic regression were conducted as follows:

Assumption 1: The outcome of interest is dichotomous

Logistic regression is only suitable for the dichotomous dependent variable. This study met this assumption, and the outcome variable was a binary variable measuring participants' physical activity coded as "1" = physically active and "0" = physically inactive. Furthermore, dietary behavior was coded as "1" = healthy eating habit and "0" = unhealthy eating habit.

Assumption 2: Linearity in the logit for continuous variables

Logistic regression assumes the linearity of predictor variables and the log odds (Stoltzfus, 2011). Nonlinearity exists if the test is statistically significant between the continuous variable and the logit of the outcome variable. In this case, converting continuous variables to categorical variables would overcome the nonlinearity issue. This assumption was tested using the Box-Tidwell test, which showed non-statistical significance. Thus, the linearity between the independent variable and the logit of the dependent variable is met.

Assumption 3: Multicollinearity

Multicollinearity occurs when the correlation between two or more predictor variables is high (Stoltzfus, 2011). The absence of multicollinearity was tested by calculating tolerance and variance inflation factors (VIF). If the tolerance value is less than .10 and the VIF value exceeds 10, it often suggests a problem with multicollinearity. In this study, multicollinearity was calculated for all the predictor variables included in the first model showing a low correlation between the variables, with all variance inflation factor values less than 10 and tolerance values exceeding .10 (Appendix C).

Assumption 4: Outliers

Logistic regression assumes the lack of strongly influential outliers (Stoltzfus, 2011). Outliers are identified if the values of the probabilities are less than ".001". Outliers in this study were calculated via a Mahalanobis test. No values less than .001 were observed. Thus, the lack of outliers assumption was met.

Logistic regression Equations

Physical Activity = Age + Gender + Family Hx + smoking status + college major + stress level + BMI + T2DM Knowledge + environmental variables

Dietary Behavior = Age + Gender + Family Hx + smoking status + college major + stress level + BMI + T2DM Knowledge + environmental variables

Physical Activity = Perceived Susceptibility + Perceived Severity + Benefits + Barriers + Self-efficacy

Dietary Behavior = Perceived Susceptibility + Perceived Severity + Benefits + Barriers + Self-efficacy

A correlation matrix was used to examine the relationships between Perceived Susceptibility (PSC), Perceived Severity (PSV), Perceived Benefits, Perceived Barriers, Self-efficacy (SE), and Physical Activity (PA), and Dietary Behavior (Diet). (See Table 11)

The diabetes knowledge scale consisted of two main subscales. The first subscale was about medical knowledge, and the second was about signs and symptoms and dietary knowledge. Each subscale consisted of 4 items. Each item had true, false, and don't know options. Items 1 to 8 were coded as a numerical value where "True" responses = 1, and "False" and 'Do not know" responses= 0. The total knowledge scores ranged from 0 to 8. The sum of subscale scores was calculated for each participant. Higher total scores represented better knowledge of T2DM. Later, the PI categorized the participant's knowledge of T2DM into high, moderate, and low levels based on the percentiles (i.e., 25%, 50%, and 75%).

The HBM scale consisted of 24 items with four main subscales, i.e., perceived susceptibility, perceived severity, perceived barriers, and perceived benefits. Participants were asked to choose one choice that started from strongly disagree to strongly agree. The total scores for each subscale were calculated separately. For example, the perceived susceptibility subscale contained five items, and the scores ranged from 5 to 30. Similarly, the perceived severity subscale consisted of 5 items, and the scores ranged from 5 to 30. The perceived benefits contained six items, so the possible score range was from 6 to 36. Finally, the perceived barriers subscale contained eight items with scores ranging from 8 to 48. Along similar lines, the third scale included ten questions with two main subscales: self-efficacy about dietary habits and physical activity. Each subscale consisted of 5 items, so the total possible score for each subscale ranged from 5 to 30. Data were categorized into high, moderate, and low levels for both scales based on the percentiles (i.e., 25%, 50%, and 75%).

Finally, the Perceived Stress Scale (PSS) included ten items to assess stress levels. Participants were asked to choose one of the choices that started from Never and ranged to

Very Often based on their stress level in the last month. Scores ranged from 0 to 40; higher scores indicated a greater stress level. After summing the total scores for each participant, the stress level was categorized based on the PSS scoring categories by Cohen (1994), i.e., low stress (ranging from 0 to13), moderate stress (ranging from 14 to 26), and high stress (ranging from 27 to 40).

For measuring environmental factors questions, composite scores for the two questions were measured as 0 if responses were "No" and 1 if the response was "Yes" in either question.

Moreover, dietary behavior questions were measured as 0 scores if the response was "never," 1 if the response was 1 per week, 2 if the response was 2 per week, 3 if the response was 3 per week, and 4 if the response was more than 4 per week. In addition, for questions assessing healthy food choices, coding was from 0 for the response "never" to 4 for the response "more than 4 per week," while questions that assessed unhealthy food choices were reversely coded as 4 for the response "never" to 0 for the response "more than 4 per week". Composite scores of responses were calculated and reported. Later, participants' dietary behavior was categorized into a dichotomous variable as healthy and unhealthy dietary behavior. For example, the total scores for each participant were divided by the number of questions to determine the mid-point score. Accordingly, the PI decided on the cut-off point of healthy and unhealthy dietary behavior. Likewise, responses were collected as continuous data for physical activity (PA) by multiplying the number of days by the minutes spent in PA for those who reported one or more days. Later, the PI categorized the responses into a dichotomous variable as either the participant following the recommended physical activity or not based on the recommended PA, i.e.,150 min/week.

Data management

Participation in this study was voluntary. The consent form was developed based on the Institutional Review Board (IRB) requirements, and the approval of the IRB was obtained via Kent State University before data collection. Incentives were distributed randomly to 50 participants to increase the response rate. Participants were asked to provide their cell phone numbers for the opportunity to enter a drawing to win US$20. A file with a secure password on secured computers was created to store data. Data were used only for research purposes.

The Healthy Communities Research Initiative Distinguished Dissertation Awards at Kent State University funded this research. The total cost for the study was= US$ 1,088. A student subscription to the SPSS for a year= is US$ 88, and the incentives for 50 participants is = US$1000 (each US$ 20). An online random number generator was used to select winners based on their ID numbers. Winners were contacted via text messages to send them the $20 in cash or online, depending on their preferences to receive it.

Additionally, to minimize validity threats, the PI created a few questions at the beginning of the survey to ensure that participants met the inclusion criteria. For example, there were two responses to whether participants were currently studying at U.S. universities: "Yes" or "No." Accordingly, if participants selected "No," the survey ended using skip logic. Conversely, age was collected as a continuous variable, and any participants under 18 years old were excluded from the study. All instruments used in this study were tested for their validity and reliability.

Pilot study Result

Reliability and validity of the instruments

Participants

Data collected from Saudi international college students living in the United States from different majors and class ranks (i.e., freshman, sophomore, junior, senior, masters, doctoral, and professional) were gathered in the Spring quarter of 2021. Hundred twenty-six participants completed the survey. Twenty-six were excluded from the survey due to incomplete half or all of the survey items. Of the hundred participants, 57 % were female. The mean age of the sample was 28 (SD = 4.68), with the overwhelming majority currently enrolled in American universities (76%). Forty-six percent of the sample were Master's students, and 33 % were undergraduate students.

Procedure

The study was a psychometric study of understanding T2DM-related scales. Quartiles survey from Kent state university was sent via WhatsApp to Saudi college students living in The United States. An explanation message was written to ask group members to fill out the online survey, which was also forwarded to students living in the United States.

Content Validity is defined as how well the particular sampling of behavior used to measure a trait or characteristic reflects performance or standing on the whole domain of behavior that constitutes that trait" (Allen and Yen, 1979). According to Allen and Yen (1979), content validity is best ensured during the scale construction phase by following a careful construct definition. Therefore, to ensure the content validity of the diabetes knowledge scale, expert judgment by diabetes specialists and consultants has assessed the questions' content.

Measures

The survey includes four scales (i.e., diabetes knowledge, health belief, self-efficacy, and stress scale). The first is the diabetes knowledge scale adapted from the DKQ" Diabetes knowledge questionnaire" (Garcia et al., 2001; Merzah, 2014). The version created by Garcia et al., 2001 consisted of 24 items, which was reduced later to 17 items by Merzah, 2014. The items were even reduced to 10 items specific to assess T2DM in general based on the experts' opinions. Responses were assigned a numerical value for analysis (i.e., True= 1, False=0, Don't know= 0). After conducting factor analysis on the diabetes knowledge scale, two items out of the ten were deleted (i.e., items #1 & 5). Therefore, The total number of the diabetes knowledge items remained is eight items that consist of two subscales; the first subscale about medical knowledge (i.e., items # 2,3,4 & 6) and the second subscales about signs and symptoms and dietary knowledge (i.e., items #7,8,9 &10).

The second scale to assess health beliefs related to T2DM, the survey consists of a 24-item divided into four subscales measuring four constructs of the Health Belief Model theory (i.e., five items for perceived susceptibility, five items for perceived severity, six items for perceived benefits, and eight items for the perceived barriers). HBM scale was created by Tovar et al. (2010); and was used among the college student population (Merzah, 2014). Scales contained six points response choices (i.e., Strongly Disagree=1 to Strongly Agree=6). The higher the score, the greater the tendency to perceive susceptibility, the severity of the diseases, and the benefits of healthy behavior. The third instrument is the self-efficacy scale created by Schwarzer & Renner (2009). The scale consists of 10 items with two subscales: five items to assess self-efficacy related to nutrition (e.g., I can manage to stick to healthy foods, even if I need a long time to develop the necessary routines), and five items for physical activity (e.g., I can manage to carry out my exercise intentions, even if I feel depressed). The scales contained six points response choices (i.e., Strongly Disagree=1 to Strongly Agree=6). The higher the score, the greater self-efficacy to adhere to T2DM prevention behaviors.

The fourth instrument is a 10-item Perceived Stress Scale (PSS) created by Cohen (1994). A Likert-type response format was used to assess individuals' feelings and thoughts during the last month (e.g., how often have you felt nervous and stressed in the last month?). Responses were assigned a numerical value for analysis (i.e., Never = 0, Almost Never= 1, Sometimes= 2, Fairly Often= 3, Very Often= 4). Higher scores indicate a greater stress level.

Moreover, the Cronbach's alpha related to the dietary habits questions was .662, which is acceptable. The researcher developed demographic items. After administering the scale, items were analyzed using *Statistical Packages for the Social Sciences version 27 for mac.* Reliability coefficients were produced to evaluate the psychometric properties of the instrument.

Result

Internal structure

Rasch analysis: Dimensionality analysis using Rasch Principal Components Analysis of Residuals (PCAR) via Winsteps (version 4.4.5).

Dimensionality

Dimensionality was assessed using Rasch Principle Components Analysis of Residuals (PCAR). The total raw variance in observations had an eigenvalue of 16.1. Measures (i.e., Person Ability and Item Difficulty) explained 37.9% of this variance (Person Ability, 10.0%; Item Difficulty, 27.9%). The Rasch dimension explained 37.9% of the variance in observations. The unexplained raw variance had an eigenvalue equivalent to the number of assessed items (10) and represented 62.1% of the total raw variance.

PCAR analyzed the unexplained variance based on standardized residual variance as contrasts (i.e., components). The eigenvalue of contrast measures the strength of a component related to the items. The first contrast explained 17.4% of the unexplained variance with an item strength of 2.8 (i.e., the eigenvalue). Proportionally, the raw variance explained by items was approximately one and a half times the unexplained variance in Contrast 1. The second contrast explained 11.0% (item strength = 1.8) of the unexplained variance. Thus, this contrast had an eigenvalue less than two, as did all the remaining contrasts. Linacre (2019) states that eigenvalues less than two suggest that these contrasts represent the random "noise" expected in the Rasch Model. Thus, PCAR suggested one additional component impacting the outcome observed in the diabetes knowledge test in addition to the Rasch dimension.

PCAR contrasts depict sets of items orthogonal to the Rasch dimension (i.e., the first component; Linacre, 2019). Items are grouped into clusters and compared based on their item (i.e., component) loading. Typically, an identified cluster of strong positive (Cluster 1, e.g., loading > .3) or strong negative loadings (Cluster 3) within a contrast may represent an additional dimension – to the Rasch dimension – affecting items in the measure. Cluster 1 and Cluster 3 of Contrast 1 had a Pearson correlation of -.306 and a disattenuated correlation (i.e., Pearson correlation measured without error) approaching -1.00. Disattenuated correlations below .570 or strongly negative values support the existence of additional components affecting items (Linacre, 2019). Clusters 1 and 3 are typically observed, including the items with the largest item loadings (positively and negatively, respectively). The items in Contrast 1, Cluster 1 pertained to signs and symptoms. The items in Contrast 1, Cluster 3 were related to medical knowledge. (Table 7)

Item Characteristics

Item Difficulties. The item characteristics for the HBM scale are listed in Table 8. descriptives for each item were generated to identify floor or ceiling effects. For the HBM scale (i.e., Likert), all items were similar, and the standard deviations were close to 1 or above. Similarly to other scales (i.e., self-efficacy and stress scale).

For the diabetes knowledge scale (dichotomous measurement for the responses), the total mean score of the medical knowledge subscale was higher than the signs and symptoms and dietary knowledge subscale, 2.93 and 1.04, respectively. In item # 2 (i.e., The usual cause of diabetes is a lack of adequate insulin in the body), about 84% of 100 correctly answered the question. A high percentage of correct answers was also observed on item# 3 (i.e., In untreated diabetes, the amount of sugar in the blood usually increases; 67%), Item #4 (i.e., If

I am diabetic, my children have a higher chance of being diabetic; 65%), item #6 (i.e., Diabetics should take extra care when cutting their toenails; 77%). On the other hand, most participants lacked knowledge in the second subscale of the diabetes knowledge (i.e., signs and symptoms and dietary knowledge subscale). For instance, only 10 % of participants out of 100 answered the items correctly for item # 7 (i.e., Diabetes can cause loss of feeling in my hands, fingers, and feet). Item #8 (i.e., Shaking and sweating are signs of high blood sugar) was correctly answered by 31% out of 100. While 29% of participants answered item #9 (i.e., Frequent urination and thirst are signs of low blood sugar) correctly, and 34% answered item# 10 (i.e., A diabetic diet consists mainly of special foods) correctly. That indicates that the second subscale items were difficult. It might be written either in medical vocabulary or in complex format.

Item-total Correlations. The item-total correlations show the correlation between the item with other items on the scale. According to Nunnally & Bernstein (1994), a general rule in examining the internal consistency reliability is that the item-total correlation should be above .30 to add to measurement quality. Thus, items that did not produce item-total correlations of .30 or above were scrutinized. For the current study, only two items in the diabetes knowledge were slightly lower than the .30 cut-off specified by Nunnally and Bernstein (1994) (i.e., item #4 "if I am diabetic, my children have a higher chance of being diabetic" and Item # 10 "A diabetic diet consists mostly of special food"). That suggests that these items are not adding to the overall quality of the diabetes scale. However, since it is slightly lower than the cut-off, it is decided to keep them. Additionally, two items in the HBM scale did not meet the cut-off point (i.e., item 18, "I have access to exercise facilities or equipment," and item #19, "I have someone who will exercise with me"). Again, since it is slightly lower than the cut-off, it is decided to keep them.

Alpha. Coefficient Alpha (Cronbach's α) is the extent to which the items are correlated with each other (Allen & Yen, 1979; Nunnally & Bernstein, 1994). For the current study, α for the KR-20 for the diabetes knowledge scale with its two subscales was .53 for medical knowledge items and .61 for signs and symptoms and dietary knowledge items. The Cronbach's alpha of less than .70 could be due to a small number of the scale items (Tavakol & Dennick, 2011). Thus, any reliability value between .50 to .70 on a scale with small items, such as the diabetes knowledge scale, would be acceptable. (Tables 5 & 6)

Additionally, the fourth construct in the HBM subscales was calculated by SPSS and had a satisfactory internal consistency with a Cronbach's alpha of .94 for perceived susceptibility, .85 for perceived severity, .62 for perceived benefit, and .66 for perceived barriers. The perceived barriers subscale had negative correlations due to the negative wording of some of the items (i.e., 17, 18, 19, 20, 21, and 22). However, those questions were reversely coded, and accordingly, the reliability improved.

Furthermore, the Coefficient alpha in the Self-efficacy scale had a satisfactory internal consistency. The Cronbach's alpha for the subscales health food self-efficacy was .94, and for exercise, self-efficacy was .92. Similarly, for the perceived stress level, the coefficient alpha was .89.

Discussion of the pilot study

A pilot study was conducted by PI on the Saudi international students living in the United States. Exploratory Factor analysis was done on the diabetes knowledge scale only due to the reduction and modification of some items by PI based on the experts' opinion. Content validity can be measured based on the previous literature review, representation of the relevant population, or based on experts' opinions (Grove, Burns, & Gray, 2013). In this study, content validity was used to assess the validity of the scales by consulting four experts in the field of diabetes, public health, research methods, and psychometry. In addition to validity, all scales had a satisfactory internal consistency after assessing the reliability. Therefore, all scales used in this study (i.e., diabetes knowledge scale, HBM scale, self-efficacy scale, dietary habits, and stress scale) have shown to be reliable and valid.

Table 2

Scale Item Descriptive for the Diabetes knowledge Scale "medical knowledge Subscale" (N= 100)

Item			Freq	%	Cumulative%
2.	The usual cause of diabetes is a lack of	0	16	16.0	16.0
	effective insulin in the body	1	84	84.0	100
3.	In untreated diabetes, the amount of sugar in	0	33	33.0	33.0
	the blood usually increases	1	67	67.0	100
4.	If I am diabetic, my children have a higher	0	35	35.0	35.0
	chance of being diabetic	1	65	65.0	100
6.	People with diabetes should take extra care	1	23	23.0	23.0
	when cutting their toenails	0	77	77.0	100

Table 3

Scale Item Descriptive for the Diabetes knowledge Scale "signs and symptoms and dietary knowledge Subscale" (N= 100)

Item			Freq	%	Cumulative%
7.	Diabetes can cause loss of feeling in my	0	90	90.0	90.0
	hands, fingers, and feet	1	10	10.0	100
8.	Shaking and sweating are signs of high blood	0	69	69.0	69.0
	sugar	1	31	31.0	100
9.	Frequent urination and thirst are signs of low	0	71	71.0	71.0
	blood sugar.	1	29	29.0	100
10.	A diabetic diet consists mostly of special	1	66	66.0	66.0
	foods	0	34	34.0	100

Table 4

Descriptive for subscales of diabetes knowledge scales (N=100)

Subscales		Min	Max	M	SD
1.	Medical knowledge subscale (i.e., 2,3,4,&6)	0	4	2.93	1.130
2,	Signs and symptoms and dietary knowledge subscale (i.e., 7,8,9 &10)	0	4	1.04	1.171

Table 5

Item-total Correlations and Alpha if Item Deleted for the Diabetes knowledge Scale "medical knowledge Subscale" (N= 100)

Item		M if Item Deleted	Var. if Item Deleted	Item-Total Correlation	α if Item Deleted
3.	The usual cause of diabetes is a lack of effective insulin in the body	2.09	.911	.329	.459
4.	In untreated diabetes, the amount of sugar in the blood usually increases	2.26	.740	.387	.396
5.	If I am diabetic, my children have a higher chance of being diabetic	2.28	.850	.224	.551
6.	Diabetics should take extra care when cutting their toenails	2.16	.823	.360	.426

Table 6

Item-total Correlations and Alpha if Item Deleted for the Diabetes knowledge Scale "signs and symptoms and dietary knowledge Subscale" (N= 100)

Item		M if Item Deleted	Var. if Item Deleted	Item-Total Correlation	α if Item Deleted
7.	Diabetes can cause loss of feeling in my hands, fingers, and feet	.94	.986	.493	.510
8.	Shaking and sweating are signs of high blood sugar	.73	.765	.481	.469
9.	Frequent urination and thirst are signs of low blood sugar.	.75	.816	.423	.519
10.	A diabetic diet consists mostly of special foods	.70	.919	.248	.660

Table 7

Principle Components Analysis of Residuals (PCAR) Item Loadings

Item	Contrast	Cluster	Loading	Measure	Item Content
7	1	1	.73	2.16	Diabetes can cause loss of feeling in my hands, fingers, and feet.
8	1	1	.70	.59	Shaking and sweating are signs of high blood sugar.
9	1	1	.64	.70	Frequent urination and thirst are signs of low blood sugar.
10	1	1	.41	.43	A diabetic diet consists mostly of special foods.
1	1	2	.08	2.58	Eating too much sugar and other sweet foods is a cause of diabetes.
6	1	3	-.64	-1.79	People with diabetes should take extra care when cutting their toenails.
3	1	3	-.58	-1.19	In untreated diabetes, the amount of sugar in the blood usually increases.
4	1	3	-.51	-1.09	If I am diabetic, my children have a higher chance of being diabetic.
2	1	3	-.35	-2.32	The usual cause of diabetes is a lack of effective insulin in the body.
5	1	2	-.28	-.07	Regular exercise will increase the need for insulin or other diabetic medication.

Note. Items are listed relative to their cluster and item loading in Contrast 1.

Table 8

The HBM Scale Item Descriptive (N = 100)

	Item	Min	Max	M	SD	Var
1.	It is likely that I will suffer from Type II Diabetes in the future	1	6	3.26	1.495	2.24
2.	My chances of suffering from Type II Diabetes in the next few years are great	1	6	3.21	1.493	2.23
3.	I feel I will have a Type II Diabetes sometimes during my life	1	6	3.34	1.532	2.35
4.	Having a Type II Diabetes is currently a possibility for me	1	6	3.39	1.595	2.54
5.	I am concerned about the likelihood of having Type II Diabetes in the near future	1	6	3.33	1.589	2.53
6.	Having a Type II Diabetes is always fatal	1	6	3.24	1.465	2.15
7.	Having a Type II Diabetes will threaten my relationship with my significant other	1	6	3.19	1.555	2.42
8.	My whole life would change if I had a Type II Diabetes	1	6	4.08	1.550	2.40
9.	Having a Type II Diabetes will have a very bad effect on my sex life	1	6	3.81	1.536	2.36
10.	If I have a Type II Diabetes, I will die within 10 years	1	6	2.66	1.673	2.80
11.	Increasing my exercise will decrease my chances of having a Type II Diabetes	1	6	4.78	1.382	1.91
12.	Eating a healthy diet will decrease my chances of having a Type II Diabetes	1	6	4.75	1.480	2.19
13.	Eating a healthy diet and exercising for 30 minutes most days of the week is one of the best ways for me to prevent Type II Diabetes	1	6	5.06	1.179	1.39
14.	When I exercise, I am doing something good for myself	1	6	5.27	1.004	1.01
15.	When I eating healthy I am doing something good for myself	1	6	5.36	.984	.96
16.	Eating a healthy diet will decrease my chances of dying from Type II Diabetes	1	6	4.95	1.193	1.42
17.	I don't know the appropriate exercises to perform to reduce my risk of developing Type II Diabetes	1	6	3.66	1.552	2.41
18.	I have access to exercise facilities and/ or equipment	1	6	4.02	1.456	2.12
19.	I have someone who will exercise with me	1	6	3.29	1.533	2.35
20.	I don't have time to exercise for 30 minutes a day on most days of the week	1	6	3.49	1.605	2.58
21.	I don't know what is considered a healthy diet that would prevent me from developing Type II Diabetes	1	6	3.19	1.398	1.95
22.	I don't have time to cook meals for myself	1	6	3.73	1.659	2.75
23.	I can't afford to buy healthy food	1	6	2.92	1.353	1.83
24	I have other problems more important than worrying about diet and exercise	1	6	3.54	1.636	2.68

Chapter Summary

The chapter discussed information related to the methodology used in this dissertation. The chapter included information about the sample size needed, the inclusion and exclusion criteria, the instruments, and their reliability and validity. Furthermore, data collection, incentives, data management, data analysis, study limitations, and ethical consideration were explained.

Chapter 4

Results

Introduction

Chapter 4 will provide the findings of the study and their implications. The chapter provides the descriptive statistics, characteristics of participants, and logistic regression results. This correlational study examines the influence of health beliefs and other risk factors on behavioral outcomes among Saudi college students living in the United States. The study seeks to answer the following questions:

1- What is the association between students' risk factors (i.e., age, gender, family history, major, level of stress, BMI, knowledge, and environmental variables) and physical activity and dietary habits in Saudi Arabian university college students living in the United States?

2- Is there an association between health beliefs (i.e., perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and self-efficacy) and physical activity and dietary habits among the selected population?

Descriptive Findings

The total sample population for this study was 419 graduate and undergraduate students from different majors, including health-related and other majors, who were enrolled in United States universities and English Language Institutions. The survey was launched on March 24, 2022, and collected most responses within five weeks.

Data were analyzed after cleaning the data by identifying and deleting the outliers and evaluating the logistic regression assumptions. Two outliers were detected for unrealistic height and weight with a value of fewer than 90 centimeters and a value of weight less than 30; that is, it is not a realistic adult height and weight. Age had one outlier, with values of under 18 years, considering that the undergraduate age starts at 18 years and above.

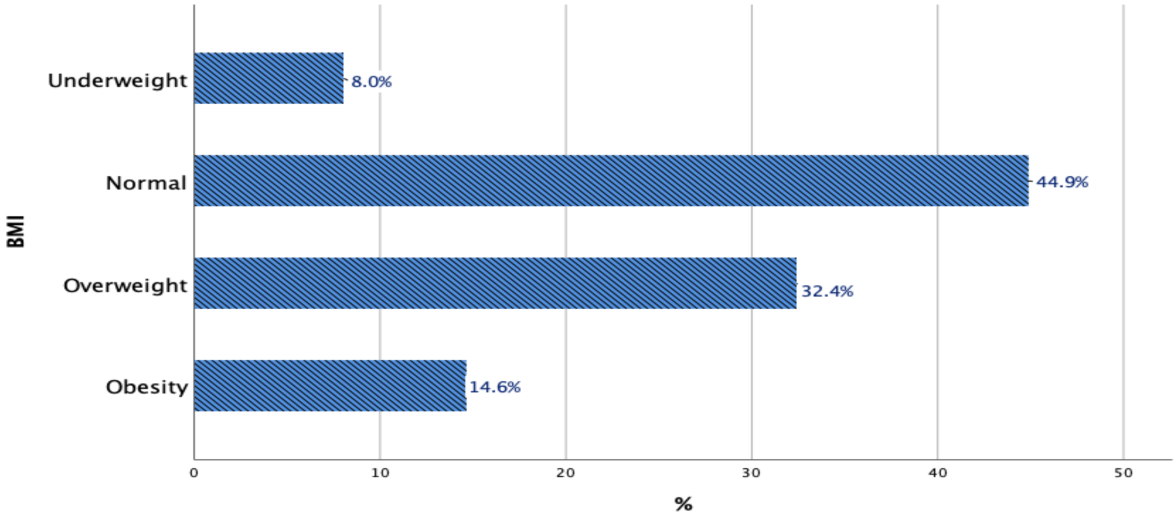
Participants who did not fill out more than 70% of the survey were excluded (n=4), and participants who were not students in USA universities (n=2) were also excluded. Before the analysis, cases that did not meet the inclusion criteria and all outliers were removed from the analysis. Thus, the total cases excluded from the study were 9, and the remaining sample size was 410.

In terms of the study participants, 54% were male. The distribution of participants' age was as follows: 59.1% between 18 to 29 years, 38.8% between 30 to 39 years, and 2% 40 years or older. The mean age of participants was 28 years (SD ± 5.68). The majority of the participants were in non-health majors, 68.7%. About 58.5% were graduate students. Body mass indexes (BMI) were obtained based on the self-reported height and weight and calculated based on the BMI formula (i.e., weight (kg)/ height (cm)/ height (cm)x 10,000). Calculated BMI shows that 8% of the participants were underweight (BMI < 18.5), and 44.9% were normal weight (BMI 18.5 to <25). The prevalence of obesity (BMI ≥ 30) was 14.6%, and 32.4% for overweight (BMI 25.5 to <30). Males suffered from both being overweight (39.1%) and obese (20.5%) more than females (24.2% overweight and 8.1% obese). There was also a significant difference in the BMI between graduate and undergraduate students, where graduate students seem to be more overweight (36%) and obese(17.1%) compared to undergraduates (overweight 28% and obese 11.4%). Obese participants perceived a higher level of susceptibility (17%) compared to overweight (7%) or not overweight (3.8%) ($p<.05$).

Those who have a family history of type 2 diabetes were 57.2%. There was insufficient evidence to support the significant association between family history and perceived susceptibility or severity. Current smokers represented 22.1%. There was a significant difference between male and female smoking status ($P<.005$), where current male smokers were 30% more female than 12%. No difference was observed between majors regarding their smoking status. The majority of participants reported moderate levels of stress (93.9%).

Furthermore, results show that 61% had a low level of knowledge about T2DM, and 29% had a moderate level, with only 10% having a high level of knowledge. Regarding physical activity, about 46.7% of participants use the free gym on a university campus or in public areas. Only 19% benefit from the services provided by the YMCA.

Figure 2: BMI Percentages



Regarding the health belief model constructs, about 59.5% reported low perceived susceptibility to T2DM. Similarly, participants' self-efficacy toward healthy eating and physical activity was low at 57.4% and 67.9%, respectively. On the other hand, high levels of overall perceived benefits of a healthy lifestyle in the prevention of T2DM were reported by 56.5%, and about 80% of participants reported the specific benefit of being physically active for at least 30 minutes most days of the week and eating a healthy diet as one of the best ways to prevent T2DM. Perceived severity was reported as moderate by 57.6%. Additionally, barriers to engaging in healthy behaviors were reported as follows: lack of time to exercise (31%) or eat healthy (42%), lack of social support (61%), lack of knowledge about a healthy diet (41%), and lack of knowledge about appropriate exercises to perform to reduce the risk of developing Type II Diabetes (56%). Other issues that prevent them from healthy behaviors were also reported at moderate levels (35%). Most students in the current study reported their ability to eat healthy food (66%) and access to a gym or equipment (76%).

To discover the association between physical activity and dietary behavior, dietary behavior was run as an independent variable while controlling other variables. Results showed that physical activity was predicated by fruit consumption (AOR= .128, 95% CI: .021 – .799), vegetables intake (AOR= .059, 95% CI: .005 – .702), and milk consumption (AOR=.052, 95% CI: .007 – .389). This study also found that lower french fries intake was related to being more physically active (AOR=.046, 95% CI: .005 – .397), and similarly, chocolate intake was inversely associated with physical activity (OR=.041, 95% CI: .004 – .430); however, there was no association found between energy drinks and physical activity.

Table 9 shows participants' dietary habits, with 60.1% reporting unhealthy eating habits. For instance, the consumption of french fries 3 times per week was 37.3%. Consumption of more than 4 times per week was reported for sweet snacks such as chocolate, muffins, and cookies, and sweet drinks such as juices, Frappuccino, and sodas at 28.7% and 34.6%, respectively. The majority of participants were physically inactive (76.1%), whereas males (27.7%) tended to be more engaged in physical activity than females (18.9%). Health-related majors (27%) were more likely to follow the recommended physical activity than other majors (23%). About 47% of females generally had healthy dietary habits compared to 34% of males; however, reported chocolate intake of more than 4 per week was higher among females (37%) than males (23%).

Table 9

Descriptive of Dietary Habits

Variable		Count	%
Breakfast	Never	30	7.4
	1 per week	62	15.2
	2 per week	69	17
	3 per week	70	17.2
	More than 4 per week	176	43.2
Fruit	Never	59	14.5
	1 per week	90	22.1
	2 per week	79	19.4
	3 per week	90	22.1
	More than 4 per week	90	22.1
Vegetables/salad	Never	40	9.8
	1 per week	69	16.9
	2 per week	110	27
	3 per week	75	18.4
	More than 4 per week	114	27.9
Milk	Never	76	18.8
	1 per week	101	24.9
	2 per week	90	22.2
	3 per week	55	13.6
	More than 4 per week	83	20.5
Fast-food	Never	37	9.1
	1 per week	148	36.4
	2 per week	95	23.3
	3 per week	80	19.7
	More than 4 per week	47	11.5
French fries/chips	Never	47	11.6
	1 per week	90	22.2
	2 per week	82	20.2
	3 per week	151	37.3
	More than 4 per week	35	8.6
Sweet snacks and chocolate	Never	46	11.3
	1 per week	69	17
	2 per week	80	19.7
	3 per week	95	23.3
	More than 4 per week	117	28.7
Sweet drinks	Never	44	10.8
	1 per week	79	19.4
	2 per week	61	15.0
	3 per week	82	20.1
	More than 4 per week	141	34.6
Energy drinks	Never	271	66.1
	1 per week	36	8.8
	2 per week	32	7.8
	3 per week	24	5.9
	More than 4 per week	47	11.5

Overall Score of the Outcome

The dietary behavior scores were summed for individuals to create category scores ranging from 1 to 24 as poor dietary habits and 22 to 34 as healthy dietary habits. The mean score was 19.3 (SD ±6.24) with a minimum of 1 and a maximum of 34. After multiplying the number of days of physical activity and the number of minutes of physical activity per week, the scores were summed for participants who were physically active and categorized into physically inactive for 0 to 149 min/week, and physically active scores equal to or greater to 150 min/week. The categorization was based on the CDC's recommended minutes of physical activity for adults (i.e., 150 min/week). The mean score was 91.3 (SD ±104.9) with a minimum of 0 and a maximum of 540 (Table 10).

Table 10

Outcome Score Descriptive Information

	Dietary behavior	**Physical activity**
N	393	289
Mean	19.30	91.30
Std. Deviation	6.24	104.90
Minimum	1	0
Maximum	34	540

The following logistic regression equations were developed to better understand the relationship between variables:

Physical Activity = Age + Gender + Family Hx + smoking status + college major + stress level + BMI + T2DM Knowledge + environmental variables

Dietary Behavior = Age + Gender + Family Hx + smoking status + college major + stress level + BMI + T2DM Knowledge + environmental variables

Physical Activity = Perceived Susceptibility + Perceived Severity + Benefits + Barriers + Self-efficacy

Dietary Behavior = Perceived Susceptibility + Perceived Severity + Benefits + Barriers + Self-efficacy

As a first step before conducting logistic regression, it is helpful to understand the (bivariate) relationships between predictor variables and the outcome. In the correlation matrix (See Table 11), dietary behavior and perceived susceptibility, perceived benefits, barriers, and self-efficacy were highly correlated and negatively correlated with perceived barriers. Physical activity and self-efficacy were also highly correlated.

Table 11

Correlation Matrix for Health Belief Model and Self-Efficacy Variables Related to Physical Activity and Dietary Behavior

	PSc	PSv	PBn	PBr	SE	PA	Diet
PSc	1.00						
PSv	.464**	1.00					
PBn	-.031	.079	1.00				
PBr	.386**	.321**	.129*	1.00			
SE	.019	.159**	.251**	.013	1.00		
PA	.101	.024	.061	-.003	.217**	1.00	
Diet	.134**	.022	.102*	-.192**	.308**	.343**	1.00

Note: *$P<.05$, **$P<.01$, two-tailed.

Descriptive statistics of the outcome variables

The dietary behavior scores variable was split into two categories at the score of 23 as a cut-off point. Scores equal to or below 23 are considered unhealthy eating habits, and scores above 24 are considered healthy. Participants with unhealthy eating habits account for 60.1% of all participants.

Unhealthy dietary behaviors were reported by 26.2% of current smokers, while healthy diets were reported by 71.2% of those who never smoked and had high perceived benefits (59.9%). Unhealthy diets were reported by those who had moderate stress levels (96.8%), lack of self-efficacy (61.2%), lack of T2DM knowledge (60%), and high perceived barriers (50%). The age group 18 to 29 (70.4%) was more likely to engage in unhealthy dietary behaviors than other ages. According to the Chi-Square test, gender and perceived barriers significantly impacted dietary behaviors (Table12).

Table 12

Chi-Square Test for Association Between Independent Variables and Dietary Behavior

Variable		**Dietary Behavior**				**Chi-Square**
		Inactive		**Active**		
		N	**%**	**N**	**%**	***P*-value**
Demographics						
Gender	Male	139	59.7	73	46.8	<.001*
	Female	94	40.3	83	53.2	
Major	Health major	74	32.6	43	30.1	.610
	Other major	153	67.4	100	69.9	
Smoking	Never smoked	124	53.2	109	71.2	<.001*
	Former smoker	48	20.6	20	13.1	
	Current smoker	61	26.2	24	15.7	
Family history	Yes	137	58.8	86	55.5	.518
	No	96	41.2	69	44.5	
Age	18-29	162	68.6	65	41.4	<.001*
	30-39	68	28.8	82	52.2	
	40 thru highest	0	0.0	6	3.8	
BMI	Underweight	20	8.5	12	7.6	.695
	Normal	100	42.4	75	47.8	
	Overweight	81	34.3	46	29.3	
	Obesity	35	14.8	24	15.3	
Stress level	Low	4	1.8	5	3.5	<.001*
	Moderate	213	96.8	130	90.3	
	High	3	1.4	9	6.3	
Knowledge	Low	84	60	47	62.7	<.001*
	Moderate	47	33.6	15	20	
	High	9	6.4	13	17.3	
YMCA	Yes	39	18	30	20.4	.561
	No	178	82	117	79.6	
Access to gym	Yes	108	49.1	65	44.2	.359
	No	112	50.9	82	55.8	
Perceived susceptibility	Low	136	59.1	93	61.6	.792
	Moderate	80	34.8	51	33.8	
	High	14	6.1	7	4.6	
Perceived severity	Low	85	37.4	58	38.4	.980
	Moderate	131	57.7	86	57	
	High	11	4.8	7	4.6	

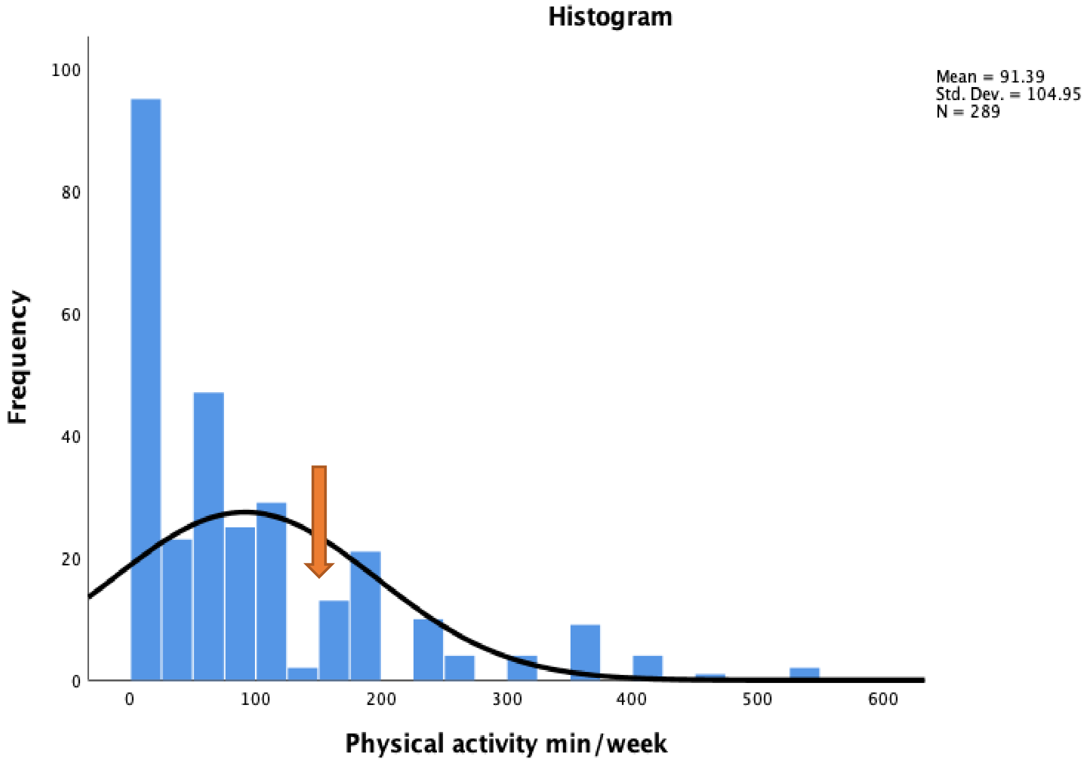
Table 12 Continued

Variable		Dietary Behavior Inactive N	%	Active N	%	Chi-Square *P*-value
	Low	28	12.3	25	16.9	
Perceived benefit	Moderate	63	27.8	44	29.7	.349
	High	136	59.9	79	53.4	
	Low	77	34.7	50	34.2	
Perceived barriers	Moderate	111	50	88	60.3	<.001*
	High	34	15.3	8	5.5	
	Low	137	61.2	71	51.1	
Self-efficacy	Moderate	64	28.6	49	35.3	.165
	High	23	10.3	19	13.7	

*Statistically significant at the .05 level.

The physical activity frequency was examined by constructing the histogram shown in Figure 3. The physical activity scores variable was split into two categories at the 150-point mark because it appears to reflect the clearest cut-point in the data (see Figure 4). Scores equal to or above 150 min per week of physical activity are considered physically active, and scores below 150 are considered physically inactive—participants with physical inactivity account for 76.1% of all participants.

Figure 3: Histogram for Physical Activity Score Distribution.



Physical inactivity was reported by 76.1% (n=220) of participants. Males were more likely to follow the recommended physical activities (PA) (64.7%) than females (35.3%). Physical activity was higher among participants who reported their beneficence of the environmental factors (21%) than those who did not use them (7%). On the other hand, physical inactivity was reported by participants who had a low level of self-efficacy toward PA (65.9%). Chi-square showed that self-efficacy and gender did not have not statistically significant effects on physical activity, while perceived susceptibility and benefits statistically affected the outcome (Table 13).

Table 13

Chi-Square Test for Association Between Independent Variables and Physical Activity

Variable		Physical Activity Inactive N	%	Active N	%	Chi-Square *P*-value
Demographics						
Gender	Male	115	52.8	44	64.7	.083
	Female	103	47.2	24	35.3	
Major	Health major	69	33.7	25	38.5	.479
	Other major	136	66.3	40	61.5	
Smoking	Never smoked	124	57.9	46	67.6	<.001*
	Former smoker	41	19.2	2	2.9	
	Current smoker	49	22.9	20	29.4	
Family history	Yes	128	59.0	38	55.9	.651
	No	89	41	30	44.1	
Age	18-29	126	57.3	40	58	.515
	30-39	86	39.1	27	39.1	
	40 thru highest	3	1.4	2	2.9	
BMI	Underweight	12	5.5	1	1.4	.104
	Normal	111	50.5	33	47.8	
	Overweight	71	32.3	31	44.9	
	Obesity	26	11.8	4	5.8	
Stress level	Low	7	3.4	3	4.8	.853
	Moderate	193	92.1	58	92.1	
	High	8	3.8	2	3.2	
Knowledge	Low	69	56.6	24	60	.772
	Moderate	39	32	13	32.5	
	High	14	11.5	3	7.5	
Environmental Factors						
YMCA	Yes	40	19.8	15	23.4	.531
	No	162	80.2	49	76.6	
Access to gym	Yes	103	50.2	45	69.2	<.001*
	No	102	49.8	20	30.8	
HBM						
Perceived susceptibility	Low	116	54.2	52	77.6	<.001*
	Moderate	88	41.1	13	19.4	
	High	10	4.7	2	29.4	
Perceived severity	Low	71	33.6	29	43.9	.263
	Moderate	128	60.7	35	53	
	High	12	5.7	2	3	
Perceived benefit	Low	26	12.5	8	12.1	<.001*
	Moderate	54	26	28	42.4	
	High	128	61.5	30	45.5	

Table 13 Continued

Variable		**Physical Activity**				**Chi-Square**
		Inactive		**Active**		
		N	**%**	**N**	**%**	***P*-value**
	Low	70	34.1	26	39.4	
Perceived barriers	Moderate	119	58	35	53	.736
	High	16	7.8	5	7.6	
	Low	139	65.9	37	57.8	
Self-efficacy	Moderate	63	29.9	20	31.3	.117
	High	9	4.3	7	10.9	

*Statistically significant at the .05 level.

Table 14

Sample Demographics and Descriptive statistics

Variable		**Count**	**%**
Risk Factors			
Gender	Male	220	54.2
	Female	186	45.8
Major	Health-related major	121	31.3
	Other major	266	68.7
Smoking	Never smoked	244	60.5
	Former smoker	70	17.4
	Current smoker	89	22.1
Family history	Yes	231	57.2
	No	173	42.8
Age	18-29	236	59.1
	30-39	155	38.8
	40 thru highest	8	2
BMI	Underweight	33	8
	Normal	184	44.9
	Overweight	133	32.4
	Obesity	60	14.6
Stress level	Low	11	2.9
	Moderate	355	93.9
	High	12	3.2
Knowledge	Low	136	61
	Moderate	64	28.7
	High	23	10.3
Environmental Factors			
YMCA	Yes	72	19
	No	307	81
Use of gym	Yes	179	46.7
	No	204	53.3

Table 14 Continued

Variable		Count	%
HBM			
Perceived susceptibility	Low	237	59.5
	Moderate	140	35.2
	High	21	5.3
Perceived severity	Low	149	37.8
	Moderate	227	57.6
	High	18	4.6
Perceived benefit	Low	55	14.1
	Moderate	115	29.4
	High	221	56.5
Perceived barriers	Low	130	33.9
	Moderate	210	54.7
	High	44	11.5
PA Self-efficacy	Low	265	67.9
	Moderate	108	27.9
	High	17	4.4
Diet Self-efficacy	Low	218	57.4
	Moderate	119	31.3
	High	43	11.3
Outcome			
Dietary behavior	Unhealthy	236	60.1
	Healthy	157	39.9
PA behavior	Inactive	220	76.1
	Active	69	23.9

Overall Score of the T2DM Knowledge

The scores were summed for individuals to create category scores with a range of 1 to 5 as low, 6 for moderate, and 7 to 8 as high levels of knowledge. The average knowledge score was 4.85 (SD ±1.47) with a minimum of 2 and a maximum of 8.

All knowledge items were divided into two subscales. The first subscale assessed medical knowledge about T2DM, signs, and symptoms, and diabetic diet. Among these knowledge subscales, about 32.6% of participants answered all the medical knowledge questions correctly, 37.6% answered 3 out of 4 questions correctly, 21% responded correctly to 2 of the medical knowledge items, and 2.7% answered 1 question correctly. The percentage was 5.4 for those who answered incorrectly or did not know. The overall mean score of medical knowledge was 2.89 (SD±1.06). On the other hand, only 3.3% of participants correctly answered items related to signs and symptoms and a diabetic diet. About 27% answered 3 out of 4 items correctly, 40.9% answered 2 items correctly, and 21% answered only 1 item correctly. About 7.4% of the answers were either incorrect or did not know responses. The mean overall score of signs and symptoms and diabetic diet subscale items was 1.98 (SD±.95) (Table 15).

Table 15

Summary of Knowledge Subscales

Knowledge subscale	Mean	Std. Deviation	Range
Medical Knowledge about T2DM	2.89	1.06	1-4
T2DM Signs & Symptoms and Diet	1.98	.958	1-4

Chi-square showed that major, family history, perceived severity, perceived benefits, and perceived barriers had statistically significant effects on T2DM knowledge.

A high level of knowledge was reported by 10.7% of respondents who never smoked compared with former smokers (9.3%) and current smokers (7.4%). Forty percent of those with a moderate level of knowledge benefited from environmental factors, and those with a low level did not use any of the environmental factors, 65.8%. A moderate to a high level of knowledge was reported by 41.2% and 11.8% of those with high perceived benefits of a healthy lifestyle for T2DM prevention compared to those with low knowledge (10%). Participants who reported low self-efficacy toward eating healthy were 73.6% compared to those with high knowledge and high self-efficacy (15.6%). Likewise, participants who reported low self-efficacy toward PA were 70.4% compared to those with high knowledge and high self-efficacy (30%). The age group, 30 to 39, reported moderate to high levels of knowledge at 33.7% to 18.6% compared to younger ages with 23.8% to 5.6%, respectively. High knowledge scores were reported by health-related majors (18.3) compared to other majors (6.1%).

Overall Score of the HBM constructs & Self-Efficacy

Health beliefs about T2DM were assessed using 24 items, including four main constructs (i.e., perceived susceptibility, perceived severity, perceived benefits, and perceived barriers). Self-efficacy was measured using two main subscales: the first one about physical activity and the second one about healthy dietary habits. The scores were summed for individuals for each health belief model construct and self-efficacy in each of the dimensions of eating habits self-efficacy and physical activity self-efficacy to create category levels.

The overall summary of the Health Beliefs Model and self-efficacy are presented in Table 16, with mean and standard deviation for each subscale. The perceived susceptibility scores range from 5 to 13 as low, 14 to 22 as moderate, and 23 to 29 as high. The average perceived susceptibility score was 12.6 (SD ±5.55) with a minimum of 5 and a maximum of 29. The score of perceived benefits ranges from 6 to 21 as low, 22 to 30 as moderate, and 31 to 36 as high. The average perceived benefits score was 29.4 (SD ±7.71) with a minimum of 6 and a maximum of 36. The score of perceived barriers ranges from 8 to 22 as low, 23 to 33 as moderate, and 34 to 46 as high. The average perceived barriers score was 25.7 (SD ±6.16) with a minimum of 8 and a maximum of 46.

When self-efficacy was investigated, the sum of perceived severity, eating habits self-efficacy, and physical activity self-efficacy scores ranged from 5 to 20 as low, 21 to 25 as moderate, and 26 to 30 as high. The average perceived severity score was 14 (SD ±4.61) with a minimum of 5 and a maximum of 30. In addition, his average eating habits self-efficacy score was 19 (SD ±6.14) with a minimum of 5 and a maximum of 30. The average physical activity self-efficacy score was 17 (SD ±5.44), with a minimum of 5 and a maximum of 30.

Study results indicate that most participants did not feel susceptible to T2DM and did not believe in the seriousness of the disease. However, they believed in healthy behaviors' benefits and perceived moderate barriers toward healthy actions. In the study, most participants could not take action toward a healthy diet and physical activity with other challenges and stressors. Moreover, most participants reported that they did not have someone to exercise with them.

Table 16

HBM &SE Scores Descriptive Information

	Perceived susceptibility	Perceived severity	Perceived benefits	Perceived barriers	SE Eating habit	SE Physical activity
N	398	394	391	384	380	390
Mean	12.6	14	29.4	25.7	19	17
Std. Deviation	5.55	4.61	7.71	6.16	6.14	5.44
Minimum	5	5	6	8	5	5
Minimum	29	30	36	46	30	30

Overall Score of the Stress

The scores for stress were summed for individuals to create category scores with a range of 0 to 13 as low, 14 to 26 for moderate, and 27 to 40 as a high level of stress. The average stress score was 20.1 (SD ±4.05) with a minimum of 6 and a maximum of 32 (Table 17). After conducting a t-test for stress scores as a continuous variable, health-related majors were statistically significantly higher in stress with a mean of 20.72 (SD ± 4) compared to other majors (P<.05). According to ANOVA, there was a statistically significant difference in stress levels between academic ranks. For instance, undergraduates reported higher stress than graduates (P<.05). BMI was also associated with stress level, with underweight, overweight, and obese participants being more likely to have stress than those with a normal BMI (P<.05). Those with a family history had higher stress than those without (P<.05). Furthermore, the higher the T2DM knowledge, the lower the stress scores, and the higher barriers, the higher the stress scores (P<.05) (Table 18).

Table 17

Stress Score Descriptive Information

N	378
Mean	20.1
Std. Deviation	4.05
Minimum	6
Maximum	32

Table 18

The Association between Stress and Independent Variables.

One way ANOVA	***P-value***
Stress * Smoking status	.191
Stress * Self-efficacy	<.005*
Stress * Perceived benefits	.372
Stress * Perceived barriers	<.005*
Stress * T2DM knowledge	.015*
Stress * Gender	.140
Stress * Major	.025*
Stress * Academic rank	<.005*
Stress * Age Group	.271
Stress * Family history	.002*
Stress * Perceived susceptibility	.119
Stress * Perceived severity	.246
Stress * BMI	.002*

The following section describes the frequency of students with chronic diseases such as diabetes and hypertension and who reported a family history of diabetes.

Table 19 shows the number of participants who reported a current diagnosis of diabetes, hypertension, and a family history of diabetes. A large majority (57.2%) of the 401 total sample had at least one of their first-degree relatives diagnosed with T2DM. About 5% of participants had diabetes, and 8.1% were currently diagnosed with hypertension. Around 14.5% of participants reported being both diagnosed with pre-diabetes and having a family history of T2DM, and 8.1% reported having T2DM and family history. In addition, about 17.4% of former smokers had been diagnosed with T2DM compared with those who had never smoked (3% (P<.05)). Pre-diabetes was reported in 26% of former smokers and 10.1%

of current smokers compared with 6% of individuals who never smoked. Prediabetes was higher in the age group of 30 to 39 years (16%) than 18 to 29 years (6%) (P<.05). However, there were no differences between age groups in the current diagnosis of T2DM and also no differences between majors in prediabetes and T2DM. Furthermore, there was no difference in pre-diabetes and T2DM between gender.

Table 19

The descriptive of participants with chronic diseases or family history of T2DM.

Current health status	Number of participants	%
Currently diagnosed with pre-diabetes	43	10.6
Currently diagnosed with T2DM	20	5.0
Currently diagnosed with hypertension	33	8.1
Have family history	231	57.2
Currently diagnosed with pre-diabetes & have a family history	33	14.5
Currently diagnosed with T2DM & have a family history	18	8.1

What is the association between students' risk factors (i.e., age, gender, family history, major, level of stress, BMI, knowledge, and environmental variables) and physical activity and dietary habits in Saudi Arabian university college students living in the United States?

Table 20 shows the results of the multivariable logistic regression model to ascertain the effects of the independent variables on physical activity. The logistic regression analysis results are presented as Adjusted Odds Ratios (AORs) with 95% confidence intervals (CI)) Moreover, the statistical significance was at $P< 0.05$. The model explained 15.4% (Nagelkerke R^2) of the variance in physical activity behavior and correctly classified 77.2% of cases. The Hosmer-Lemeshow goodness of fit test had a non-significant *P*-value of .056, suggesting that the model is a good fit for the data.

The bivariate analysis in Table 13 shows that the risk factors associated with physical activity were smoking and gym use. After holding all other variables constant, the multivariable logistic regression analysis found that smoking, family history, and access to the gym were statistically significant ($P<0.05$) in their relationships to physical activity. The other remaining independent variables were non-significant. The study results revealed that participants with a family history of T2DM were seven times (AOR = 7.594, 95% CI: 2.048 – 28.163) more likely than those without a family history to perform physical activities. An inverse association between smoking and physical activity indicates that former and current smokers were less likely to be physically active than participants who never smoked (AOR = .040, 95% CI: .004 – .414). The study also revealed that people who had access to a gym were more likely to perform physical activity than those who did not (AOR = 36.836, 95% CI: 5.853– 231.840).

Table 20

Summary of the Adjusted Multivariable Logistic Regression Analysis of the Effects of the Risk Factors on Physical activity among Saudi Arabian University Students in the United States.

Variable		*P*-values	AOR	95% C.I. for EXP(B) Lower	Upper
Risk Factors					
Gender	Male	.099	3.246	.802	13.132
	Female	*	*	*	*
Age		.130	1.091	.975	1.220
Smoking	Never Smoked	.593	.695	.183	2.634
	Former Smoker	.007*	.040	.004	.414
	Current Smoker	.026*	*	*	*
Family History	Yes	.002*	7.594	2.048	28.163
	No	*	*	*	*
Major	Health-related	*	*	*	*
	Other Major	.662	.770	.238	2.492
BMI		.753	1.222	.351	4.260
Stress Level	Low	*	*	*	*
	Moderate to high	.126	.318	.073	1.380
T2DM Knowledge Level	Low	.561	2.042	.184	22.620
	Moderate	.569	1.974	.190	20.537
	High	.837	*	*	*
YMCA	Yes	.098	3.243	.805	13.062
	No	*	*	*	*
Access to gym	Yes	<.005*	36.836	5.853	231.840
	No	*	*	*	*

* Statistically significant at the .05 level.

Table 21 shows the results of the multivariable logistic regression model to ascertain the effects of the risk factors on dietary behaviors. The logistic regression analysis results are presented as Adjusted Odds Ratios (AORs) with 95% confidence intervals (CI)) Moreover, statistical significance was at *P*< 0.05. The model explained 65.4% (Nagelkerke R^2) of the variance in the dietary behavior and correctly classified 90.3% of cases. The Hosmer-Lemeshow goodness of fit test had a non-significant *P*-value of .809, suggesting that the model is a good fit for the data.

Bivariate analysis in table 12 shows that the risk factors associated with dietary behavior were gender, smoking, age, stress, and T2DM knowledge. Likewise, smoking, stress, and T2DM knowledge were associated in the multivariable logistic regression analysis while holding all other variables constant. However, YMCA as an environmental factor was associated with dietary habits in the logistic regression result, unlike the chi-square, and gender was not associated with dietary habits. There is an inverse relationship between smoking and dietary habits, indicating that former and current smokers were less likely to eat healthy than those who never smoked (AOR = .012, 95% CI: .001 – .171). There is also an inverse association between stress and dietary behavior, indicating that people with moderate to high-stress levels (AOR = .013, 95% CI: .003 – .504) were less likely to engage in healthy dietary habits than those with low levels of stress. Furthermore, people with high levels of T2DM knowledge were more likely to follow healthy eating habits than those with low levels of T2DM knowledge (AOR = 82.5, 95% CI: 2.11 – 3212.1). The study also found that people who benefit from the services provided by the YMCA were more likely to engage in healthy diets than those who did not benefit from such services (AOR = 45.6, 95% CI: 3.99 – 754.5) (Table 20).

Table 21

Summary of the Adjusted Multivariable Logistic Regression Analysis of the Effects of the Risk Factors on Dietary Behavior among Saudi Arabian University Students in the United States.

Variable		***P*-values**	**AOR**	**95% C.I. for EXP(B) Lower**	**Upper**
Risk Factors					
Gender	Male	.320	2.289	.448	11.705
	Female	*	*	*	*
Age		.056	4.917	.959	25.209
Smoking	Never Smoked	.221	.258	.029	2.258
	Former Smoker	.001*	.012	.001	.171
	Current Smoker	.005*	*	*	*
Family History	Yes	.163	3.735	.585	23.830
	No	*	*	*	*
Major	Health-related	.888	1.144	.176	7.444
	Other Major	*	*	*	*
BMI	Underweight	.013	.004	.000	.312
	Normal	.404	.335	.026	4.354
	Overweight	.570	1.978	.188	20.853
	Obesity	.050	*	*	*
Stress Level	Low	*	*	*	*
	Moderate to high	.013*	.041	.003	.504
T2DM Knowledge Level	Low	.059	*	*	*
	Moderate	.325	2.409	.419	13.863
	High	.018*	82.506	2.119	3212.15
YMCA	Yes	.003*	45.601	3.999	754.511
	No	*	*	*	*
Access to gym	Yes	.580	1.563	.322	7.595
	No	*	*	*	*

* Statistically significant at the .05 level.

Is there an association between health beliefs (i.e., perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and self-efficacy) and physical activity and dietary habits among the selected population?

The bivariate analysis in Table 13 shows that the health belief constructs associated with physical activity were perceived susceptibility and perceived benefits. After holding all other variables constant, the multivariable logistic regression analysis found that perceived susceptibility and perceived benefits were statistically significant ($P<0.05$) in their relationships to physical activity. The other remaining independent variables were non-significant. The study results revealed that participants with a higher level of perceived susceptibility were more likely to engage in physical activities than those with a low level of perceived susceptibility (AOR = .637, 95% CI: .073 – 5.531). The study also found that the people with a higher level of perceived benefits were four times (AOR = 4.530, 95% CI: 2.015 – 10.18) more likely to be physically active than those with low levels of perceived benefits (Table 22).

Table 22

Summary of the Adjusted Multivariable Logistic Regression Analysis of the Effects of the Health Belief constructs on Physical activity among Saudi Arabian University Students in the United States.

Variable		***P*-values**	**AOR**	**95% C.I. for EXP(B) Lower**	**Upper**
HBM					
	Low	.518	2.018	.240	17.00
Perceived Susceptibility Level	Moderate	.683	.637	.073	5.531
	High	.029*	*	*	*
	Low	.555	1.856	.238	14.443
Perceived Severity Level	Moderate	.716	1.470	.185	11.694
	High	.734	*	*	*
	Low	.731	1.221	.391	3.811
Perceived Benefit Level	Moderate	<.005*	4.530	2.015	10.183
	High	.001*	*	*	*
	Low	.472	1.687	.405	7.024
Perceived Barriers Level	Moderate	.822	1.165	.308	4.413
	High	.624	*	*	*
	Low	.691	.766	.205	2.858
Self-Efficacy Level	Moderate	.970	.974	.247	3.843
	High	.797	*	*	*

* Statistically significant at the .05 level.

In terms of dietary behavior, the bivariate analysis in Table 12 shows that the health belief constructs associated with dietary habits was perceived barriers. However, the regression analysis while holding all other variables constant in Table 23 shows that perceived susceptibility, perceived benefits, and perceived barriers were statistically significant ($P<0.05$) in their relationships to dietary habits. The other remaining independent variables were non-significant. The study revealed that people with higher levels of perceived susceptibility were more likely to eat healthier than those with lower levels of it. The study also found that people with higher levels of perceived benefits were more likely to eat healthier than those with lower levels (AOR = .016, 95% CI: .000 – .600). There is an inverse association between barriers and a healthy diet, indicating that those who reported fewer barriers were more likely to engage in healthy diets than those who reported more barriers (AOR = 267.7, 95% CI: 8.44 – 8489.1).

Table 23

Summary of the Adjusted Multivariable Logistic Regression Analysis of the Effects of the Health Belief constructs on Dietary Behavior among Saudi Arabian University Students in the United States.

Variable		*P*-values	AOR	95% C.I. for EXP(B) Lower	Upper
HBM					
	Low	.105	21.765	.524	903.744
Perceived Susceptibility Level	Moderate	.286	.111	.002	6.311
	High	.012*	*	*	*
	Low	.143	.030	.000	3.273
Perceived Severity Level	Moderate	.057	.008	.000	1.165
	High	.108	*	*	*
	Low	.030*	50.503	1.477	1726.72
Perceived Benefit Level	Moderate	.025*	.016	.000	.600
	High	.019*	*	*	*
	Low	.006*	*	*	*
Perceived Barriers Level	Moderate	.002*	267.76	8.446	8489.12
	High	.887	.782	.026	23.112
	Low	.146	*	*	*
Self-Efficacy Level	Moderate	.053	16.656	.966	287.283
	High	.126	9.080	.536	153.753

* Statistically significant at the .05 level.

Supplementary Analysis

Multiple linear regression was used to predict physical activity from health beliefs and other risk factors (i.e., age, gender, family history, major, level of stress, BMI, knowledge, and environmental variables) (see Appendix D). Family history of T2DM, access to gym, YMCA services high level of knowledge, and high level of perceived benefits were all positively associated with physical activity (P<.05). On the other hand, stress and perceived barriers were negatively associated with physical activity (P<.05).

Multiple regression results showing more variables associated with physical activity than logistic regression results including gender, knowledge, YMCA, and stress. In calculated predictions, males were more likely to be physically active than females, and those who perceived high level of knowledge and low level of stress were more likely to follow the recommended physical activity.

Multiple linear regression confirmed the findings from logistic regression, showing that participants who reported family history, access to gym, YMCA services, and benefits of physical activity were more likely to engage in physical activity. However, people who reported few barriers and low level of stress were more likely to be physically active.

Multiple egression results of dietary habits confirmed the findings from logistic regression, showing that knowledge, YMCA services, perceived susceptibility, and perceived benefits were positively significantly associated with dietary habits (P<.05). However, smoking, stress, and perceived barriers were negatively associated with dietary behavior (P<.05). One of the only differences between logistic and multiple regression results of dietary habits is that the gender is statistically significant (P<.05) in multiple regression. Where females were more likely to follow healthy dietary habits. (see Appendix D).

Summary: A final multivariable logistic regression conclusion, after holding all other variables constant, supported the following research hypotheses: there were significant associations between physical activity and having a family history of T2DM, having access to a gym, having a high level of perceived susceptibility and perceived benefits. In other words, these factors increased the likelihood of physical activity, while smoking decreased the likelihood of being physically active. The study also concludes that there were significant relationships between dietary habits and smoking, stress, T2DM knowledge, and YMCA as environmental factors and perceived susceptibility, benefits, and barriers as health beliefs factors. These factors increased the likelihood of either following healthy or poor eating habits while holding all other variables constant. The study concluded that self-efficacy did not predict health behaviors among the target population.

Chapter 5

Discussion

This chapter will provide a summary of the study's main findings, a discussion and interpretation of the findings, and an explanation of how they are similar to or different from findings reported in previous studies. The chapter will also cover the public health implications, future research, and the study's strengths and limitations.

Summary of Results:

This dissertation aims to examine the following research questions:

1- What is the association between students' risk factors (i.e., age, gender, family history, major, level of stress, BMI, knowledge, and environmental variables) and physical activity and dietary habits in Saudi Arabian university college students living in the United States?

2- Is there an association between health beliefs (i.e., perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and self-efficacy) and physical activity and dietary habits among the selected population?

The above research questions were answered using the Statistical Package for the Social Sciences (SPSS) software program version 26. Descriptive statistics were used to assess the overall stress, knowledge, health beliefs, and outcomes among a sample of Saudi college students in the United States. The mean age of participants was 28 years (SD ± 5.68). Over 68.7% of the 410 participants were in non-health majors. Males constituted 54% of the population, and graduate students constituted 58.5%. Overweight and obese participants represented 32.4% and 14.6%, respectively. Participants with T2DM family history were 57.2%, and 22% were current smokers. Most participants reported moderate stress levels (93.9%), and 61% lacked T2DM knowledge.

Regarding participants' health beliefs, most participants did not feel susceptible to T2DM or the seriousness of it; however, most (56.5%) believed in the benefits of engaging in healthy behaviors. About 59.5% had low levels of perceived susceptibility, and 57.6% had low levels of perceived severity of T2DM. This study found that participants reported low levels of barriers to engage in healthy behavior (54.7%) while at the same time having low self-efficacy toward healthy behaviors. In other words, although the barriers were low, many could not take action toward healthy eating habits (57.4%) and physical activity (67.9%). As a result, unhealthy eating habits were reported by 60.1%, and most participants were physically inactive (76.1%). However, males (28%) and students in health-related majors (27%) tended to be more engaged in physical activity, while females (47%) tended to have healthier dietary behavior than males (34%).

A multivariable logistic regression concluded that there were significant associations between physical activity and having a family history of T2DM, having access to a gym, and having high levels of perceived susceptibility and perceived benefit. There were significant relationships between dietary habits and smoking, stress, T2DM knowledge, and the YMCA as environmental factors and perceived susceptibility, benefits, and barriers as health beliefs factors. Smoking was inversely associated with both physical activity and healthy dietary behaviors. However, stress, knowledge, barriers, or perceived severity did not predict physical activity. Furthermore, dietary habits were not predicted by family history. Both outcomes were not predicted by perceived severity, gender, major, age, BMI, or self-efficacy.

Comprehensive Evaluation of the Health Belief Model Within the Context of Saudi Population:

Previous studies have proved that health behavior might or might not be affected by social determinants, demographics, and environmental and health belief constructs. Differing results were found depending on the target population and settings. For example, self-efficacy and perceived susceptibility were strongly associated with healthy eating behaviors (Orji, Vassileva & Mandryk., 2012). Furthermore, a study in Gyongju, Korea, found that perceived threat, self-efficacy, and cues to action were the strongest predictors of health behavior (Park, 2011). In another context, a higher level of perceived severity increased the motivation to undertake diabetes self-care behavior among Egyptian women with gestational diabetes (Tawfik, 2017). Besides these one-off results, results have also differed in the same population based on their health status. For instance, a high level of perceived severity of T2DM was reported by diabetic patients in Saudi Arabia (Albargawi, 2017; Alatawi et al., 2015). Furthermore, medication adherence was also predicted significantly by the high level of self-efficacy among Saudi diabetic patients (Alatawi et al., 2015). Albarqawi (2017) also found that diabetic patients had low self-efficacy toward regular exercise (76%), controlling their blood glucose (56%), and controlling their weight (55%). Additionally, perceived susceptibility and perceived severity were high among 220 patients with T2DM in Saudi Arabia (Alatawi et al., 2015). Another study in SA also found that the majority of participants (89%) reported high levels of perceived severity of the disease if not controlled, and 95% reported that uncontrolled diabetes leads to adverse outcomes in the future (Albarqawi, 2017).

It was noticed that the perceived threat of diabetes is lower in men, those with a low education level, the elderly, and young people (Kowall et al., 2017, Taradash et al., 2015). The current study revealed that perceived susceptibility was significantly associated with physical activity and a healthy diet, but more than half of the population had a low perceived susceptibility to T2DM and a moderate level of perceived severity. Similar to the Saudi context, the perceived susceptibility and severity of T2DM were low for both genders at 27% and 29% in Saudi adolescents (Al- Mutairi et al., 2015). This result is in contrast to some other contexts. For example, perceived severity was high among undergraduate college students in the USA, especially those with a family history (Ferrian, 2011). Likewise, findings from another study on the same population revealed that half of the students believed in the seriousness of T2DM, while those who had family history were more likely to have a high level of perceived severity and susceptibility than those who did not have a family history of T2DM (Merzah, 2014).

Researchers found higher reports of self-efficacy improved eating habits, calorie label use, and weight loss among college students in different countries (Roach et al., 2003; Cha et al., 2014). In other studies, with a 63.3% prevalence rate, moderate self-efficacy was found as a barrier to physical activity among college students in Saudi Arabia (Gawwad, 2008; Samara et al., 2015). In another study, adolescents in KSA reported moderate to high levels of self-efficacy in maintaining a healthy lifestyle, such as avoiding smoking (94%), partaking in regular exercise (50%), and consuming low fat and low sugar meals (52% and 57.5 %, respectively) (Al- Mutairi et al., 2015). Unlike other populations, healthy behavior among Saudi college students in the current study was not predicted by self-efficacy, and self-efficacy toward healthy eating habits and physical activity were low among participants at 57.4% (n=2018) and 67.9% (n=265), respectively.

Perceived benefits of engaging in healthy behaviors were high in almost all populations of both diabetics and nondiabetics (Merzah, 2014; Alatawi et al., 2015; Al-Mutairi et al., 2015; Albarqawi, 2017). However, in a study among college students in Saudi Arabia, although 77% of participants perceived the benefit of fruit and vegetable consumption, they failed to meet their recommended intake (Hakim, 2018). Findings in this study also found high levels of perceived benefits as about 80% of participants perceived the benefit of being physically active for at least 30 minutes most days of the week and eating a healthy diet as one of the best ways to prevent T2DM. Physical activity and dietary behaviors were significantly predicted by perceived benefits ($P<.05$). Additionally, barriers to engaging in healthy behaviors were reported as follows: lack of time to exercise (31%) or eat healthy (42%), lack of social support (61%), lack of knowledge about a healthy diet (41%), lack of knowledge of appropriate exercises to perform to reduce the risk of developing Type II Diabetes (56%) and other issues that prevented them from behaving healthily were also reported at the moderate level (35%). Similarly, a moderate level of barriers to a healthy lifestyle was reported in a study among adolescents in Saudi Arabia, including lack of time to exercise (46.5%), hot weather (43%), limited choices of healthy food (35%), and the unpleasant taste of low-calorie food (46.2%) (Al- Mutairi et al., 2015). Furthermore, low income (2.6%), heavy academic assignments, and a limited number of fitness centers were also barriers reported by students in Saudi Arabia (Alkhateeb et al., 2019; Kahalafalla et al., 2017). The majority of students in the current study, however, reported their ability to access healthy food (66%), and they also had access to a gym or equipment (76%); thus, the environmental factor of access to a gym was not a barrier among Saudi students living in the United States.

Discussion of Other Risk Factors

Knowledge about T2DM

Knowledge is effective in chronic disease prevention, such as that for T2DM, particularly in colleges and high schools. According to Azinge (2013), a high level of awareness motivates people to practice a healthy lifestyle. However, studies revealed that knowledge alone is insufficient to engage in healthy behavior (El-Ahmady & El-Wakeel, 2017; Arlinghaus & Johnston, 2018; Feldman & Sills, 2013).

The overall knowledge regarding diabetes among college students worldwide is low to moderate. A study conducted by Gazzaz (2020) in Saudi Arabia revealed that out of 1428 participants, only 186 (13%) had a high level of knowledge, while 569 (39.8%) had a moderate level, and 673 (47.1%) had a low level. In addition, females had a higher level of diabetes knowledge than males. In the USA, a low overall knowledge level was also observed (Merzah, 2014). However, some studies revealed that the level of knowledge about diabetes was higher among medical students than in other majors (Wajid et al., 2018; Hakim, 2018).

The results of this study are consistent with the above literature as the majority of participants had a low level of knowledge about T2DM (61%) while 29% had a moderate level, and only 10% had a high level. High knowledge scores were obtained more often by health-related majors (18.3%) than other majors (6.1%), while no significant difference was observed between genders. One explanation for this finding is that students with health-related majors learned about diabetes, its signs and symptoms, and risk factors in their academic courses, contributing to their increased knowledge. Another explanation is that students in health majors were more proactive about discussing health concerns with their health providers and were more likely to seek guidance and counseling than non-health majors (Almutairi et al., 2018).

A study conducted among college students in Saudi Arabia found that knowledge alone was not significantly associated with healthy food consumption (Al-Otaibi, 2014). However, the adjusted multiple logistic regression results from this study found that participants with a higher level of T2DM knowledge were more likely to engage in healthy dietary habits than participants with a lower level of T2DM knowledge.

Smoking

Studies have found a significant association between smoking and insulin resistance and the development of T2DM in both genders (Arslanian, 2002; Gulli et al., 1992). The prevalence of smoking among the Saudi population has been reported as 12.2% (n=10735), with the majority in the college-age group of 19 years (+/- 6.5 years) and 4.3% who reported smoking hookah daily (Morad-lakeh et al., 2015). Furthermore, Abdulrashid and his team (2018) found that the frequent use of a water pipe was reported by 39.6% of Saudi women (n=332), with the majority of them being either students or workers (Abdulrashid et al., 2018). In another study, about 91% of medical students lacked knowledge of the health risks related to smoking (Jradi & Al-shehri, 2014).

There were about 22% who reported being current smokers in this study. There was a significant difference between males and females ($P<.005$), at 30% and 12%, respectively. When comparing majors, there was no difference observed between majors in their smoking status. According to the logistic regression analysis, smoking was inversely associated with physical activity, which indicates that former and current smokers were less likely to be physically active than participants who had never smoked (OR = .040). Former and current smokers were also less likely (OR = .012) to eat healthy than those who had never smoked. This study was the first study comparing both genders and majors among Saudi college students in terms of their overall smoking status and its association with health behaviors; thus, future studies may consider smoking as a predictor variable and also focus on the difference between genders, specifically in different types of smoking such as vaping and hookah.

Family History

Family history of diabetes was significantly associated with T2DM, typically for more than one relative diagnosed with DM (Scott et al., 2013; Harrison et al., 2003). The first-cousin marriage and distant relative marriage rates are highest among the Saudi population at 28.4% and 14.6, respectively. Thus, it is not surprising that those marriages impact the prevalence of T2DM in Saudi Arabia (El-Hazmi et al., 1995). This study found that more than half of the participants (57.2%) had a family history of T2DM in immediate relatives such as parents, siblings, or grandparents.

Regarding perceptions and family history, some studies found that individuals with a family history were more likely to perceive susceptibility to and severity of T2DM than those with no family history, with 54% and 16%, respectively (Gallivan et al., 2009; Merzah, 2014). However, other studies revealed that family history was not significantly associated with perceived susceptibility or severity of T2DM and did not influence the adherence to healthy behaviors (Ferrian, 2011; Amuta et al., 2017). Results from this study among the Saudi population were consistent with the latter on the American population, as there was not enough evidence to support the significant association between family history and perceived susceptibility or perceived severity. Regarding health behaviors, this study revealed that participants with a family history of T2DM were seven times (OR = 7.594) more likely than those without a family history to perform physical activity. However, dietary behavior was not predicted by family history.

Stress

The prevalence of stress among undergraduate students in Saudi Arabia has been reported as 28.2 %, with the level of stress reported as mild (17.3%), moderate (49.1%), severe (25%), and highly severe (9%) (Almogbel et al., 2019). The results of this study among Saudi students in the U.S. observed similar stress levels as most participants reported moderate stress levels (93.9%, n=355).

The high level of stress leads to unhealthy food choices in some students, such as the consumption of high-calorie food and drinks, including energy and soft drinks, fast food, beverages, and sweets (Yau & Potenza, 2013; Dahlin, Joneborg & Runeson, 2005; Ahmed et al., 2014; Almogbel et al., 2019). Previous studies' findings are consistent with this study's results because an unhealthy diet was generally reported by those with moderate to high-stress levels (96.8%). Logistic regression analysis in this study revealed that students with moderate to high-stress levels were less likely to engage in healthy dietary habits than those with a low stress level (OR = .013).

The prevalence of stress levels has been higher among medical students at 53% than others (Rahman et al., 2013; Abdulghani, 2008). There may be various reasons for this, including the highly stressful factors such as social isolation, psychological stress, and the pressure of examinations, which has placed their health at risk of weight gain and T2DM (Shrinivasan, Vaz & Sucharita, 2006; Asghar et al., 2019). No significant difference was found between genders (Rahman et al., 2013). Similar results were found in this study, as health-related majors were statistically significantly higher in stress than other majors with a mean of 20.72 (SD $\pm$ 4) ($P<.05$), and no significant difference was obtained between gender. However, undergraduates reported higher stress levels than graduates ($P<.05$). Furthermore, underweight, overweight, and obese participants were more likely to have stress than those with a normal BMI ($P<.05$). In addition, those with a family history reported higher levels than those who did not ($P<.05$), and the higher the T2DM knowledge, the lower the stress scores, while the higher the barriers, the higher the stress scores ($P<.05$).

Being Overweight and Obesity

Obesity has been significantly associated with T2DM due to its increasing insulin resistance (Wondmkun, 2020). People who suffer from obesity perceived a high level of susceptibility and severity of T2DM (40%) compared to those who were overweight (29%) or not overweight (16%) (Gallivan et al., 2009). The current prevalence of obesity among Saudi students (n=401) was 11% for obesity and 23% for overweight (Makkawy et al., 2021). A study conducted in SA revealed that 30.7% of males were overweight and 28.4% of females, while the prevalence rate of obesity was higher among women than men, with 23.6% and 14%, respectively (Alqarni, 2016).

This study's results suggest that obese participants perceived a high level of susceptibility (17%) compared to overweight (7%) or not overweight (3.8%) ($p<.05$). However, I did not find a significant difference in the level of perceived severity between BMI categories. In contrast, I found a significant difference in BMI between genders ($p<.05$). The prevalence of obesity was 14.6% for obesity and 32.4% for being overweight, with males suffering from being both overweight (39.1%) and obese (20.5%) more than females (24.2 % overweight and 8.1% obese). There was also a significant difference in the BMI between graduate and undergraduate students, where graduates seemed more likely to be overweight (36%) and obese (17.1%) than undergraduates (28% overweight and 11.4% obese. The results of this study suggest no significant association between BMI and health behaviors (i.e., physical activity and dietary habits).

Discussion of the outcome variables

Physical Activity

Physical inactivity is a public health issue among younger ages worldwide. The current physical activity recommendation for adults between 18 to 64 is 30 minutes of moderate to vigorous physical activity at least five days a week. However, more than 45% of college students in Saudi Arabia (n=278) are not meeting this recommendation (Al-Hassan et al., 2020; Almutairi et al., 2018). In Pakistan, 48.2% of college students did not meet the recommended physical activity guidelines (Ullah et al., 2021).

The physical inactivity barriers among college students in Saudi Arabia were reported as time limitations (18.5%), lack of motivation (16.1%), unsuitable weather (7.2%), low income (2.6%), heavy academic assignments, and a limited number of fitness centers

(Alkhateeb et al., 2019; Kahalafalla et al., 2017). Similar barriers reported by Saudi college students in this study included lack of time to exercise (31%), lack of social support (61%), and lack of knowledge about the appropriate exercises to perform to reduce the risk of developing Type II Diabetes (56%), and other issues (35%). However, the majority of Saudi college students in the U.S. (76%) reported having access to a gym or equipment.

Saudi female college students had a higher rate of physical inactivity than males (Alzamil et al., 2019; Alhakbany et al., 2018). Furthermore, in one particular study, Albawardi, Jradi, and Al-Hazzaa (2016) found that the prevalence of physical inactivity among Saudi women was 52.1%. Similarly, males in another study showed more physical activity than females (OR=0.46) (Hazzaa et al., 2013).

Results from this study thus confirm Albawardi et al.'s and Hazzaa et al.'s studies, conclude that males (27.7%) were more likely to be physically active than females (18.9%). One explanation for this finding is those gender roles and the need to adhere to cultural standards usually contribute to physical inactivity among Saudi females (Aljehani et al., 2022). Almutairi et al. (2018) found that health students were more physically active than non-health students. My results were similar as the health-related majors were more likely to follow the recommended physical activity than other majors, at 27% and 23%, respectively. This finding might be due to their study of health sciences, which increases their knowledge of T2DM prevention measures and reflects positively on their physical activity behaviors. In this study, about 80% of participants reported the specific benefit of being physically active for at least 30 minutes most days of the week is one of the best ways to prevent T2DM; however, few of them were physically active (23.9%), and 76.1% did not meet the physical activity recommendation.

According to Al-Hassan et al. (2020), the perceived severity of being obese was reported by most of the participants, and most of them also perceived physical activity to be beneficial in preventing obesity, while only 50% of participants reported their susceptibility to being obese in their lifetime (Al-Hassan et al., 2020). In this study, about 80% of participants reported the specific benefit of being physically active for at least 30 minutes most days is one of the best ways to prevent T2DM; however, the majority (76.1%) did not meet physical activity recommendations, and only 40.5% of participants reported their susceptibility of being diabetic in their lifetime.

Examining the association between physical activity and health beliefs and other risk factors in this study found that participants with higher levels of perceived susceptibility were more likely to engage in physical activities than those with low levels of perceived susceptibility (OR = .637). People with higher levels of perceived benefits were four times (OR = 4.530) more likely to be physically active than those with low levels of perceived benefits of physical activity. Furthermore, participants with a family history of T2DM were seven times (OR = 7.594) more likely than those without a family history to perform physical activities. In contrast, there was an inverse association between smoking and physical activity, indicating that former and current smokers were less likely to be physically active than those who never smoked (OR = .040).

It has been found that a free public gym, such as one in a public area, encourages several physical activities, including walking (19%) and vigorous activity (16%) (Cohen et al., 2007). This study's environmental factors (i.e., YMCA services and access to a gym) statistically influenced participants’ health behaviors. Findings from this study revealed that people who had access to a gym were more likely to perform physical activity than those who did not (OR = 36.8). Physical activity was predicted by access to a gym, indicating this environmental factor's importance.

When looking at physical activity and dietary habits, according to Al-hazzaa et al. (2013), physical activity was associated with fruit consumption (OR= 1.99), vegetable intake (OR=1.27), milk consumption (OR=1.42), french fries (OR= 1.30), and energy drinks (OR=1.44). This study's findings are consistent with Al-hazzaa's study, as physical activity was predicated on fruit consumption (OR= .128), vegetable intake (OR= .059), and milk consumption (OR=.052). This study also found that the fewer french fries participants ate, the more physical active they were (OR=.046), and similarly, chocolate intake was inversely associated with physical activity (OR=.041); however, there was no association found between energy drinks and physical activity.

Dietary Habits

One study found that the percentage of college students who reported junk food consumption at least once a day in SA was 57% of the total sample (n=116), and 43% consumed soda and energy drinks daily (Khabaz et al., 2017). In addition, Al-Otaibi (2014) found that 78% of students consumed less than five servings/day of fruit and vegetable, while 22% consumed equal to or more than five servings/day. In Bahrain, a similar result was found among adolescents, as about 27.7% of students were not consumed fruits (Musaiger et al., 2011). The same study also found that about 24% consumed many potato chips. About two-thirds of Saudi Adolescents reported consuming fast food and sweetened drinks more than three times a week (Al-Hazzaa et al., 2012). Similarly, a large number of participants consumed soft drinks every day (42.2%), and females were more likely to consume sweets, chocolate, candy, doundouns, and soft drinks than males (Musaiger et al., 2011; Al-Hazzaa et al., 2012). According to Al-Hazzaa's study, females were more likely to consume French fries than males, while no difference was observed between genders in fast food consumption in Musaiger's study.

This study's results are consistent with the above literature, with 60.1% of participants reporting unhealthy eating habits. Specifically, the consumption of french fries 3 times per week was 37.3%. Furthermore, sweet snacks such as chocolate, muffins, and cookies were 28.7%, and sweet drinks such as juices, Frappuccinos, and sodas were 34.6%. Unlike previous studies, females in this study, in general, tended to have healthier dietary habits than males at 47% and 34%, respectively. However, chocolate intake was higher among females (37%) than males (23%).

The health promotion services provided by the YMCA in the United States, such as weight loss, wellness, and diabetes prevention programs, are some of the United States' environmental support that encourages adherence to diabetes prevention behaviors. In 2016-2017, a national study conducted on 50,912 non-diabetic participants in the United States found that engaging in diabetes prevention behaviors or benefiting from health promotion programs was reported by 33.5% to 75.2% of those who had elevated American Diabetes Association (ADA) risk scores (>5), and 35% to 75.8% of those who were diagnosed with prediabetes (Ali et al., 2019). This study also found that people who benefited from the services provided by YMCA were more likely to engage in healthy diets than those who did not (OR = 45.6).

Public Health Implications

The findings of this dissertation study add to the literature regarding the influence of health beliefs and other factors on physical activity and dietary behaviors.

Conducting correlational cross-sectional design studies and recruiting participants from different colleges, majors, and degrees would provide additional insight into Saudi college students' behavior toward T2DM prevention and how the environmental and other risk factors influence their behavior. Additionally, by understating college students' health beliefs, knowledge, and other predictive variables that influence their behaviors, it would be more efficient and effective to plan a prevention program for T2DM targeting this population based on how they perceive the disease, their barriers, and the environmental barriers to preventing the disease.

Furthermore, understanding the students' health beliefs about diabetes and assessing their knowledge of it helps health policymakers manage and prevent diseases properly (Gazzaz, 2020). According to the American Diabetes Association (2017), appropriate knowledge and skills regarding self-care behaviors and self-management education helps reduce costs and improve outcomes. Using HBM to explore the effect of health beliefs and other risk factors of T2DM on college students' behaviors will help future studies by providing a background about college students' health beliefs and contributing factors of T2DM.

In light of the reasons mentioned, the findings of this study may help health policymakers' decisions and the public health authority in Saudi Arabia as they are now working to prevent chronic diseases such as diabetes from achieving the 2030 Saudi vision. The significant results of this study regarding environmental factors and their influence on physical activity and dietary habits should inform policymakers and stakeholders to facilitate a healthy environment on college campuses such as fitness rooms, sidewalks, gyms, or a membership at a local gym. This study also recommends offering services such as the YMCA programs as a primary level of prevention to prevent or delay the occurrence of T2DM through a healthy lifestyle, especially among younger ages.

The ultimate findings of this study provide a general background on the health beliefs and behaviors of college students of different ages and majors and from different regions of Saudi Arabia to improve the quality of the health education programs related to diabetes and its health complications, community screening campaigns for diabetes in colleges, and better diagnostic facilities, especially in colleges' healthcare units. Better diabetes management systems and protocols by health policymakers could decrease the burden of T2DM.

A central finding of the study was that health beliefs, environmental factors, and some of the risk factors significantly influenced physical activity and dietary behaviors, suggesting the need for collaboration between stakeholders and the Ministry of Health to facilitate the delivery of educational programs in Saudi college students studying in Saudi Arabia or abroad. Developing policies that would facilitate collaboration between students with pre-diabetes, health care facilities, and community resources could promote the effectiveness of diabetes prevention programs. Findings would open the door to other researchers to improve the modified theoretical framework by investigating and adding more variables, building on the study's findings, and replicating the study in another population. Furthermore, the study results will benefit health insurance companies responsible for Saudi students in the United States or Saudi Arabia to educate their beneficiaries about the importance of early diabetes screening and health promotion programs.

Study Limitations and strengths

This study has some strengths that can be replicated in future studies. The study used a comprehensive assessment of the health beliefs model as the theoretical framework and investigated the most risk factors and environmental factors for the first time among a Saudi population outside Saudi Arabia, which is a crucial strength. The sample size of this study was appropriate for the total population of Saudi college students in the United States. Furthermore, all the scales used in this study were validated with high-reliability scores.

In the literature review, significant differences were noted regarding the burden of DM amongst the regions in Saudi Arabia. For example, the northern region of SA had the highest prevalence rate of T2DM, while the least was in the southern region (Al-Nozha et al., 2004). Furthermore, there are significant socioeconomic inequalities in the prevalence of DM in the Saudi population. For instance, a high prevalence of the disease was reported among the unemployed (32%), individuals with low education levels (32%), and those with low incomes (42.4%) (Al-Baghli et al., 2010; Al-Hanawi et al., 2020; Al Mansour, 2020). Therefore, an additional strength of this study was that participants were recruited from different regions in Saudi Arabia with almost equality in their nonemployment status and monthly income by the Saudi Arabia Cultural Mission (SACM).

On the other hand, a few limitations were identified in this study, including the recall bias. A further limitation is selection bias due to the non-probability sampling, such as convenience sampling through social media platforms. In terms of design, using a correlational cross-sectional design is another limitation of this study as it does not allow for testing causality. However, the design was deemed the most appropriate to examine the influence of health beliefs and other risk factors on physical activity and dietary behaviors among Saudi students living in the United States.

Future Research and Conclusion

In conclusion, this study is the first to evaluate the health belief model, environmental factors, and other risk factors among Saudi students in the United States. It is also more comprehensive, targets different majors and degrees, and addresses more risk factors that might influence health behaviors than the three studies that previously used health belief models (Alatawi et al., 2015; Al-Mutairi et al., 2015; Albargawi, 2017).

This dissertation has provided findings suggesting that several risk factors, including family history, stress, knowledge, smoking, and environmental factors, influenced college students' physical activity and dietary behavior. Perceived susceptibility, perceived benefits, and perceived health belief model contributed significantly to health behavior. In contrast, there was insufficient evidence to support the effect of perceived severity, age, BMI, or academic rank on college students' behavior. Overall, the results of this study could be used to help improve diabetes prevention programs. Findings could also help formulate policies related to the environment in colleges and to improve access to early screening programs for college students, either for students in Saudi Arabia or who are studying abroad through their health insurance companies. Those with impaired glucose tolerance or T2DM could be referred to specific health facilities for further medical care.

Future studies and research may replicate this study in other populations, using the validated scales to assess target populations' knowledge about T2DM, health beliefs, dietary habits, and physical activity. Additionally, conducting in-depth interviews to explore perceptions of college students, including those with and without high-risk factors of diabetes, can provide further insight into developing effective diabetes prevention programs. Future studies could assess the environment of the colleges directly.

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Appendix A

Consent to Participate in a Research Study

Study Title: *A Comprehensive Test of the Health Belief Model and Selected Environmental Factors in the Prediction of Physical Activity, Dietary Behavior, and Type 2 Diabetes Knowledge of Saudi Arabian University Students in the United States.*
Principal Investigator: Dr.Jeffrey Hallam
Co-investigator: Reham Bakhsh

You are being invited to participate in a research study. This consent form will provide you with information on the research project, what you will need to do, and the associated risks and benefits of the research. Your participation is voluntary. Please read this form carefully. It is important that you ask questions and fully understand the research in order to make an informed decision.

Purpose
We are conducting this study to investigate Saudi Arabian students' health beliefs and behaviors at U.S universities and to determine the personal and environmental factors influencing the relationship.

Procedures
If you agree to participate, you will be asked to complete demographic, diabetes knowledge, and Likert scale survey items. Please set aside 15 minutes to complete this online survey. All your responses in this study are anonymous and will not be linked to your name or any other identifying information. The data will be stored along with randomly assigned ID numbers (that are also not linked to or stored with your names or any other identifying information).

Benefits
This research will not benefit you directly. However, your participation in this study will help us to better understand Saudi Arabian students' health beliefs and behaviors at U.S universities and understand the personal and environmental factors influencing the relationship.

Risks and Discomforts
There are no anticipated risks associated with this study.

Confidentiality
We will keep your information confidential within the limits of the law, but due to the nature of the internet there is a chance that someone could access information that may identify you without permission.

Future Research
Your de-identified information may be used by or shared with other research without your additional consent.

Compensation
A $20 will be distributed randomly to 50 participants.
Voluntary

Participation in this study is voluntary. You may discontinue participation at any time without penalty or loss of benefits.

If you have any questions or concerns about this research, you may contact Jeffrey Hallam at 330-672-0679. This project has been approved by the Kent State University Institutional Review Board. If you have any questions about your rights as a research participant or complaints about the research, you may call the IRB at 330-672-2704.
To participate click the button below. If you do not want to participate, exit the window.

Appendix B

Survey

Q1 Are you an international student in the United States?

- ○ Yes
- ○ No

Q2 What is your age in years? Please type a number and round to the nearest whole number.

____

Q3 What is your gender?

- ○ Male
- ○ Female

Q4 If female, are you currently pregnant?

- ○ Yes
- ○ No

Q5 Are you currently studying English to be admitted to a college/university in the United States?

- ○ Yes
- ○ No

Q6 What is your current class rank?

- ○ Undergraduate (i.e., Freshman, Sophomore, Junior, or Senior).
- ○ Graduate (i.e., Master or Doctoral)

Q7 Your major(s)/specialization(s) is:

- ○ Health-related major
- ○ Other major

Q8 What is your height in centimetres? (Please round to the nearest whole number)

____

Q9 What is your weight in kilograms? (Please round to the nearest whole number)

____

Q10 What is your smoking status?

- ◯ Never Smoked
- ◯ Former Smoker
- ◯ Current Smoker

Q11 Do any of your immediate relatives (parents, grandparents, siblings) have Type II diabetes?

- ◯ Yes
- ◯ No

Q12 Have you been diagnosed as pre-diabetic?

- ◯ Yes
- ◯ No

Q13 Have you been diagnosed with type II diabetes?

- ◯ Yes
- ◯ No

Q14 Have you been diagnosed with high blood pressure (hypertension)?

- ◯ Yes
- ◯ No

Q15 How many days/week do you exercise?

- ○ 0 never
- ○ 1 day/week
- ○ 2 days/week
- ○ 3 days/week
- ○ 4 days/week
- ○ 5 days/week
- ○ 6 days/week
- ○ 7 days/week

Q16 For those who responded exercising one or more days/week, how many minutes per day on average?

____

Q17 How often do you eat breakfast?

- ○ 0 never
- ○ 1 per week
- ○ 2 per week
- ○ 3 per week
- ○ More than 4 per week

Q18 How many times per week do you eat fruit?

- 0 never
- 1 per week
- 2 per week
- 3 per week
- More than 4 per week

Q19 How many times per week do you eat vegetables/salad?

- 0 never
- 1 per week
- 2 per week
- 3 per week
- More than 4 per week

Q20 How many times per week do you drink milk?

- 0 never
- 1 per week
- 2 per week
- 3 per week
- More than 4 per week

Q21 How many times per week do you eat French fries/potato chips?

- 0 never
- 1 per week
- 2 per week
- 3 per week
- More than 4 per week

Q22 How many times per week do you eat fast food?

- 0 never
- 1 per week
- 2 per week
- 3 per week
- More than 4 per week

Q23 How many times per week do you eat sweets and chocolates?

- 0 never
- 1 per week
- 2 per week
- 3 per week
- More than 4 per week

Q24 How many times per week do you consume sweetened drinks such as late, juices, coke?

- 0 never
- 1 per week
- 2 per week
- 3 per week
- More than 4 per week

Q25 How many times per week do you consume energy drinks?

- 0 never
- 1 per week
- 2 per week
- 3 per week
- More than 4 per week

Q26 Have you had a chance to benefit from free health promotion services provided by YMCA, such as weight loss programs, wellness programs, and diabetes prevention programs?

- Yes
- No

Q27 Do you use the free gym (e.g., university campus or public areas)?

Yes

No

Diabetes knowledge scale

Q28 This section is about diabetes knowledge. Please read each statement and select one of the following: False, True, Don't Know.

	Items	True	False	Do not know
1	The usual cause of diabetes is a lack of adequate insulin in the body			
2	In untreated diabetes, the amount of sugar in the blood usually increases			
3	If I am diabetic, my children have a higher chance of being diabetic			
4	People with diabetes should take extra care when cutting their toenails			
5	Diabetes can cause loss of feeling in my hands, fingers, and feet			
6	Shaking and sweating are signs of high blood sugar			
7	Frequent urination and thirst are signs of low blood sugar.			
8	A diabetic diet consists mainly of special foods			

Health beliefs scale

Q29 This section is about diabetes perceptions. Please read the following statements and indicate the extent to which you disagree or agree with each.

	Items	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
1	I will likely suffer from Type II Diabetes in the future						
2	My chances of suffering from Type II Diabetes in the next few years are great						
3	I feel I will have Type II Diabetes sometimes during my life						
4	Having Type II Diabetes is currently a possibility for me						
5	I am concerned about the likelihood						

	of having Type II Diabetes soon						
6	Having Type II Diabetes is always fatal						
7	Having Type II Diabetes will threaten my relationship with my significant other						
8	My whole life would change if I had a Type II Diabetes						
9	Having Type II Diabetes will have a very bad effect on my sex life						
10	If I have Type II Diabetes, I will die within 10 years						
11	Increasing my exercise will decrease my chances of having a Type II Diabetes						
12	Eating a healthy diet will decrease my chances of having a Type II Diabetes						
13	Eating a healthy diet and exercising for 30 minutes most days of the week is one of the best ways for me to prevent a Type II Diabetes						
14	When I exercise, I am doing something good for myself						
15	When I eat healthily, I am doing something good for myself						
16	Eating a healthy diet will decrease my chances of dying from Type II Diabetes						

17	I don't know the appropriate exercises to perform to reduce my risk of developing Type II Diabetes						
18	I have access to exercise facilities and/ or equipment						
19	I have someone who will exercise with me						
20	I don't have time to exercise for 30 minutes a day on most days of the week						
21	I don't know what is considered a healthy diet that would prevent me from developing Type II Diabetes						
22	I don't have time to cook meals for myself						
23	I can't afford to buy healthy food						
24	I have other problems more important than worrying about diet and exercise						

Self-efficacy scale

Q30 This section is about self-efficacy to healthy foods. Please read the following statements and indicate the extent to which you disagree or agree with each. The following prompt should be used for each statement. I can manage to stick to healthy foods,

	Items	**Strongly Disagree**	**Disagree**	**Slightly Disagree**	**Slightly Agree**	**Agree**	**Strongly Agree**
1	even if I need a long time to develop the necessary routines.						
2	even if I have to try several times until it works.						
3	even if I have to rethink my entire way of nutrition.						
4	even if I do not receive much support from others when making my first attempts.						
5	even if I have to make a detailed plan.						

Q31 This section is about self-efficacy to exercise. Please read the following statements and indicate the context you disagree or agree with each. The following prompt should be used for each statement. I can manage to carry out my intentions to exercise.

	Items	**Strongly Disagree**	**Disagree**	**Slightly Disagree**	**Slightly Agree**	**Agree**	**Strongly Agree**
1	even when I have worries and problems.						
2	even if I feel depressed.						
3	even when I feel tense.						
4	even when I am tired.						
5	even when I am busy.						

Perceived Stress Scale (PSS)

Q32 The questions in this scale ask you about your feelings and thoughts during the last month. You will be asked to indicate by circling how often you felt or thought a certain way in each case. The following prompt should be used for each statement. In the last month,

	Items	**Never**	**Almost Never**	**Sometimes**	**Fairly Often**	**Very Often**
1	how often have you been upset because of something that happened unexpectedly?					
2	how often have you felt that you could not control the important things in your life?					
3	how often have you felt nervous and stressed?					
4	how often have you felt confident about your ability to handle your problems?					
5	how often have you felt that things were going your way?					
6	how often have you found that you could not cope with everything you had to do?					
7	how often have you been able to control irritations in your life?					
8	how often have you felt that you were on top of things?					
9	how often have you been angered because of things that were outside of your control?					
10	how often have you felt difficulties were piling up so high that you could not overcome them?					

Appendix C

Variable	Tolerance	VIF
Risk factors		
Gender	.735	1.361
Major	.746	1.340
Age	.783	1.277
Smoking	.725	1.379
Family history	.681	1.469
BMI	.692	1.446
T2DM knowledge	.756	1.322
YMCA	.629	1.589
Access to gym	.676	1.478
HBM		
Perceived susceptibility	.617	1.621
Perceived severity	.477	2.096
Perceived benefit	.589	1.698
Perceived barriers	.592	1.690
PA self-efficacy	.454	2.204
Diet self-efficacy	.460	2.172

Appendix D

Summary of the Adjusted Multiple Linear Regression of the Effects of the Health Beliefs and Risk Factors on Physical activity among Saudi Arabian University Students in the United States.

Variable	Unstandardized Coefficients B	*P*-values	95% C.I. for EXP(B) Lower	Upper
(Constant)	1.106	.025	-2.068	-.145
Gender	.174	.023	-.323	.025
Age	.007	.359	-.008	.023
Smoking	-.021	.610	-.059	.101
Family History	.259	.001	.116	.402
Major	.097	.182	-.046	.240
BMI	-.015	.119	-.034	.004
Stress	-.031	.009	.008	.054
T2DM Knowledge	.102	.001	.042	.163
YMCA	.195	.030	.019	.371
Access to gym	.345	<.005	.192	.499
Self-efficacy	.027	.693	-.109	.163
Perceived susceptibility	.167	.071	-.348	.015
Perceived severity	.134	.150	-.049	.318
Perceived benefits	.243	.002	-.391	.095
Perceived barriers	-.355	.001	-.557	-.152

* Statistically significant at the .05 level.

Summary of the Adjusted Multiple Linear Regression of the Effects of the Health Beliefs and Risk Factors on Dietary Behavior among Saudi Arabian University Students in the United States.

Variable	Unstandardized Coefficients B	*P*-values	95% C.I. for EXP(B) Lower	Upper
(Constant)	34.805	<.005	17.802	51.808
Gender	-2.257	.030	-4.296	-.219
Age	-.373	.713	-2.372	1.627
Smoking	-2.247	<.005	-3.466	-1.029
Family History	1.205	.287	-1.024	3.434
Major	-1.278	.214	-3.305	.748
BMI	-.020	.858	-.241	.201
Stress	-9.307	.010	-16.367	-2.246
T2DM Knowledge	1.812	<.005	1.001	2.623
YMCA	3.537	.016	-6.638	1.081
Access to gym	.989	.343	-3.046	1.067
Self-efficacy	.040	.958	-1.542	1.462
Perceived susceptibility	3.282	.017	-5.965	.598
Perceived severity	1.846	.173	-.818	4.511
Perceived benefits	1.759	.018	.310	3.209
Perceived barriers	-3.859	.007	-6.638	-1.081

* Statistically significant at the .05 level.