DIABETES AND PHYSICAL ACTIVITY AMONG SAUDI WOMEN

by

ZAINAB MOHAMMED HASSAN ALYOUSEF

Dissertation

Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at
The University of Texas at Arlington
August 2021

Arlington, Texas

Supervising Committee:
Dr. Donelle M. Barnes, Committee Chairs
Dr. Daisha J. Cipher, Committee Member
Dr. Deborah F. Behan, Committee Member

Acknowledgement

I would like to thank my dissertation committee, Dr. Donelle Barnes, Dr. Daisha Cipher, and Dr. Deborah Behan who supported me in each step of my dissertation and helped me during this journey. A heartful thanks goes to my mother, who passed away three years ago. She encouraged me to continue my studies, and never stopped praying for me. Thank you to my father, for being my support system during this journey. To my husband and daughters, thank you for being so patient and giving me the time to finish my Ph.D.

Abstract

DIABETES AND PHYSICAL ACTIVITY AMONG SAUDI WOMEN

Zainab Alyousef, Ph.D.

The University of Texas at Arlington, 2021

Supervising Professor: Dr. Donelle Barnes

Given the fact that Saudi women with DM have more obesity but lower levels of physical activity compared to men, and have additional cultural barriers to physical activity, new interventions are needed. Home-based interventions would be ideal as the women would not need to rely on transportation to a gymnasium or park for exercise. Although, home-based interventions are relatively low-cost, for both the patient and the healthcare system, no studies were found in which researchers tested an exercise intervention in Saudi women with DM delivered at home using the Internet. The purpose of this proposed study will be to evaluate the effectiveness of a home-based, internet-delivered exercise intervention to decrease fasting plasma glucose (FPG) and body mass index (BMI), and to increase level of physical activity in Saudi women with DM. A one-group pretest-posttest design was used in this study. A convenience sample of 20 participants was recruited from three PHC centers located in Qatif city. FPG, BMI, and level of physical activity were collected at baseline and eight weeks post intervention. There was a significant increase in participants' steps from pre to post-test, $t(19) = -2.21$, $p = 0.04$, $M = 5010.82$ (SD = 2905.01) to 5980.3 (SD = 2022.47) respectively. Also, results indicated a significant decline in FPG and BMI from pre to post-test, [$t(19) = 9.63$, $p < 0.001$, $M = 140.35$ (SD = 16.13) to 135.7 (SD = 16.23)], [$t(19) = 8.26$, $p < 0.001$ $M = 33.42$ (SD = 2.44) to 32.84 (SD = 2.49)], respectively. Findings from this study highlight the value of

increasing the levels of physical activity of Saudi women with DM. Further studies with larger sample sizes are needed to evaluate the effectiveness of physical activity programs.

TABLE OF CONTENTS

List of Illustration

List of Tables

Chapter I

INTRODUCTION

Chronic diseases, particularly type 2 diabetes mellitus (DM), are becoming serious health problems worldwide. Globally, DM is expected to be the 7th leading cause of death by 2030 (World Health Organization [WHO], 2018a). In 2016, an estimated 1.6 million deaths were associated with DM (WHO, 2018b). This chapter includes a discussion of the background and significance of the problem of DM, and the theoretical framework that will be utilized in a proposed study. It will also include a discussion of the statement of the purpose, questions, and assumptions of the theoretical framework.

Background and Significance of Diabetes

DM is a chronic disease characterized by high blood glucose (BG) levels (WHO, 2018b). It is correlated with a glycated hemoglobin (HbA_{1C}) ≥ 6.5 %, a fasting plasma glucose (FPG) > 126 mg/dL, a two-hour plasma glucose > 200 mg/dL, or a random plasma glucose > 200 mg/dL in people with classic symptoms of high sugar crisis (American Diabetes Association [ADA], 2017b).

The incidence of DM has been linked to non-modifiable (genetic) and modifiable (environmental) risk factors (Colberg et al., 2010). Although the incidence of DM can be attributed to non-modifiable factors such as family history (Bianco et al., 2013), nearly 80% rising in the prevalence of DM is attributed to the modifiable risk factors (WHO, 2015). The modifiable risk factors include obesity, physical inactivity, and unhealthy dietary habits (WHO, 2015).

Although DM is incurable, researchers continue to affirm that to prevent or delay the onset of DM complications, maintaining optimal levels of BG, lipids, and blood pressure is

fundamental (ADA, 2017b). To maintain diabetic patients' health and reduce the risk of diabetes complications, health care providers should customize the treatment plan to each person. Typically, DM treatment plan involves a pharmacological therapy and lifestyle modifications, including healthy diet and physical activity (ADA, 2017b).

Physical activity has been identified as "any bodily movement produced by skeletal muscles that requires energy expenditure" (WHO, 2018c, para. 1). It is the cornerstone of managing DM (Colberg et al., 2010). The term exercise refers to planned, structured, and repetitive movement (WHO, 2018b). For optimal health outcomes, individuals with DM should engage in at least 150 minutes per week of moderate or higher intensity exercise (Colberg et al., 2010). Engaging in regular physical activity has been associated with various positive health outcomes in people with DM such as improvement in HbA_{1C} (Sung & Bae, 2012), quality of life (Myers et al., 2013), and cardiometabolic profile (Cugusi et al., 2015).

Although regular physical activity has many benefits, particularly for adults with DM, a striking prevalence of physical inactivity has been reported among women with DM in Saudi Arabia (SA). According to Bahirji et al. (2016), about 71.3% of women in SA are physically inactive or engage in less than an hour per week of planned physical activity. The previous study highlighted the need for an intervention to increase the level of physical activity, particularly among Saudi women with DM. Further studies of Saudi women can help to advance the quality of nursing care as well as improve diabetic outcomes in SA.

Globally, the number of diabetic adults over 18 years old has increased dramatically from 4.7% in 1980 to 8.5% in 2014 (WHO, 2018b). In 2017, there were 3.8 million reported cases of diabetes in SA (International Diabetes Federation [IDF], 2019). According to the IDF (2013), SA is ranked in the top 10 countries worldwide for the prevalence of DM.

Uncontrolled DM can have devastating effects on individuals. It can lead to chronic complications such as DKD, diabetic retinopathy, diabetic neuropathy, coronary artery disease, peripheral arterial disease, and stroke (Fowler, 2008; 2011).

Description of the Theory: Health Promotion Model

In the early 1980s, Pender (1982) originally developed the initial version of the health promotion model (HPM) based on the theoretical perspective of two health behavioral theories: expectancy value theory and social cognitive theory. Expectancy value theory describes perceived benefits of action (Pender et al., 2001). The more people perceive the value of their goals, the more likely they are to work to achieve them (Peterson & Bredow, 2013). Social cognitive theory describes perceived self-efficacy. The greater the levels of self-efficacy people possess, the greater the likelihood that they will be committed to the given behavior (Bandura, 1993).

The HPM serves as "a guide for exploration of the complex biopsychosocial processes that motivate individuals to engage in health behaviors directed toward the enhancement of health" (Pender, 1996, p. 51). It comprises two fundamental categories of influencing factors and a third category of behavior outcomes (Pender et al., 2001; Illustrated in Figure 1). The first category, individual characteristics and experiences, refers to the distinctive individual traits and experiences that influence peoples' prospective behaviors. This category consists of prior behaviors and personal factors. The second category in this model is the behavior-specific cognitions and affect. This category has been classified as the major motivational significance for health promotion behavior (Pender et al., 2001). It consists of a set of concepts that are proposed to predict individuals' health promoting behaviors, which are perceived benefits of action, perceived barriers to action, perceived self-efficacy, activity related affect, interpersonal

influences, and situational influences. The third category is the behavioral outcome. Behavioral outcome consists of three concepts; commitment to a plan of action, immediate competing demands and preferences, and health promotion behavior, that is, the desired outcome (Pender et al., 2001).

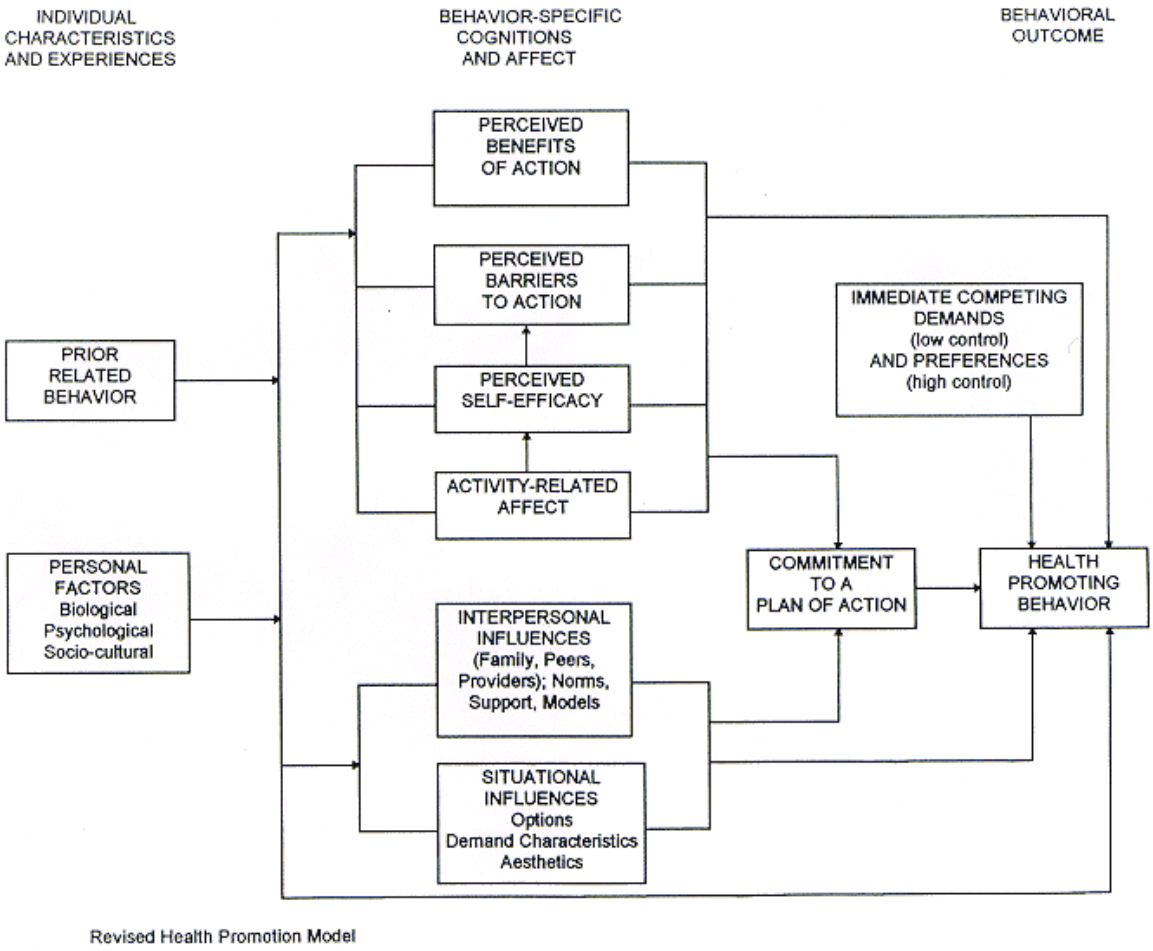


Figure 1: Health Promotion Model (Pender et al., 2001)

Health Promotion Model Main Concepts

The HPM consists of eleven concepts, which are proposed to predict people's health promotion behaviors. Below are definitions of each concept identified within this model.

Prior related behavior. Prior related behavior accounts for the previous occurrences of the targeted behavior or any similar behavior (Pender et al., 2001). The habit formation of the previously performed activity motivates the person to resume that activity (Pender et al., 2001). For instance, a person who previously participated in a sport is more likely to resume the same activity.

Personal factors. Personal factors refer to the biologic, psychologic, and sociocultural factors that may influence the likelihood of undertaking health promoting behavior (Pender et al., 2001). Personal factors involve variables such as age, gender, and socioeconomic status (Galloway, 2003). These factors can increase or decrease the likelihood of action. For example, the more an individual's income increases, the more likely he or she is to utilize preventive services (Galloway, 2003).

Perceived benefits of action. Perceived benefits of action is defined as the individual's belief about the affirmative result of a health promoting behavior (Peterson & Bredow, 2013). For example, a diabetic person's beliefs about the importance of exercise in lowering his or her elevated BG will motivate him or her to participate in exercise regimens.

Perceived barriers to action. Perceived barriers to action refers to the individuals' beliefs about obstacles they encounter when attempting to carry out a health promoting behavior, such as beliefs about the expense and difficulty of a specific action (Peterson & Bredow, 2013). The more barriers to health promoting behavior a person perceives, the less likely he or she is to carry out that behavior. For example, a person who believes that he or she does not have enough time to exercise will not commit to an exercise regimen because of this belief.

Perceived self-efficacy. Self-efficacy refers to people beliefs about their own ability to perform a certain activity (Bandura, 1993). A person does not need to possess a particular skill

to undertake a certain health behavior; rather, he or she needs to believe in his or her own abilities (Pender et al., 2001). For instance, as a smoker's sense of self-efficacy increases, there is a greater likelihood that the individual will quit smoking. However, overestimation or underestimation of one's abilities is not efficient (Pender et al., 2006). The most efficient efficacy judgment is the one that slightly exceeds a person's current capabilities (Pender et al., 2006).

Activity related affect. Activity related affect refers to the positive or negative personal emotions that occur in association with health promoting behavior (Pender et al., 2001). For instance, enjoyment is a positive emotion that motivates the health behavior (Motl et al., 2001), while fear is a negative emotion that interferes with the behavior (Pender et al., 2001). An example that illustrates this concept would be a person who experiences enjoyment associated with physical activity. This person would be more likely to repeat and maintain the activity than the person who experiences fear.

Interpersonal influences. Interpersonal influences refer to personal perceptions pertaining to the behaviors, values, and attitudes of others (Peterson & Bredow, 2013). Family, peers, and healthcare providers are the main sources of interpersonal influence, which involve expectations of significant others, social support, and modeling (Pender et al., 2001). A typical example of this concept would be a diabetic person whose peers provide emotional support and participate in exercise regimens in solidarity with the person. Consequently, the peers provide the motivation for the person to remain engaged in the exercise regimens.

Situational influences. Situational influences refer to personal beliefs pertaining to the given environmental contexts (Pender et al., 2001). A person's perceptions about the environment can include beliefs about available options, demand characteristics, and aesthetic

features (Pender et al., 2001). Situational factors may affect the health promoting behaviors. For example, losing weight will be more challenging for a person who has only high-fat food options available (Galloway, 2003), and quitting smoking may be easier for a person working for an employer that has a no smoking policy (Pender et al., 2001). These situational influences can both motivate and demotivate people to display certain behaviors.

Commitment to a plan of action. Commitment to a plan of action refers to the state of being obligated to carry out a health promoting behavior whereby an individual set a time and place to carry out the planned behavior with a companion or alone (Peterson & Bredow, 2013). For example, a person has a commitment to exercise if he or she sets a specific time and place to exercise in his or her daily schedule.

Immediate competing demands or preferences. Immediate competing demands or preferences refer to the occurrences of distracting thoughts prior to a person's carrying out a planned behavior (Peterson & Bredow, 2013). Competing demands include life commitments such as work and family responsibilities, while competing preferences are related to attractive activities such as shopping (Pender et al., 2001). Both immediate competing demands and preferences may interfere with an individual's planned health promoting behavior (Peterson & Bredow, 2013). For example, a person may respond to competing preferences by driving to the shopping mall instead of the recreation center because the person prefers shopping over exercise (Pender et al., 2001). This example illustrates how competing demands interfere with a planned behavior.

Health-promoting behavior. Health promoting behavior is the desired outcome in the HPM (Pender et al., 2001). It refers to the activities that people perform consistently as a central part of their lifestyles such as physical activity, healthy eating, and development of social support

system (Pender, 1982). As a result of the commitment to a health promoting behavior, a person can experience improved health, functional ability, and quality of life (Pender et al., 2006). For example, a recently diagnosed diabetic person who commits to healthy diet and regular physical activity can decrease the likelihood of developing diabetes complications, thus, improving his or her health outcomes.

The Relationships between the Concepts: Propositions

Pender's HPM is based on several theoretical propositions (Pender et al., 2001). Below are the statements that are derived from the model and highlight the relationship between the concepts:

- Prior related behavior is positively associated with perceived benefits and negatively associated with perceived barriers to action.
- Prior related behavior is positively associated with self-efficacy and activity related affect.
- Personal factors including biological factors are negatively associated with health promoting behavior.
- Personal factors including psychological and sociocultural factors are positively associated with health promoting behavior.
- Perceived benefits to action and self-efficacy are positively associated with commitment to a plan of action and health promoting behavior.
- Perceived barriers to action is negatively associated with commitment to a plan of action and health promoting behavior.
- Perceived self-efficacy is negatively associated with perceived barriers to action.

- Positive affect toward a behavior is positively associated with perceived self-efficacy, commitment to a plan of action and health promoting behavior.
- Interpersonal influences including high levels of expectation of significant others, social support, and modeling are positively associated with commitment to a plan of action and health promoting behavior.
- Positive situational influences on health promotion behavior are positively associated with commitment to a plan of action and health promoting behavior.
- Commitment to a plan of action is positively associated with health promoting behavior.
- Immediate competing demands and preferences are negatively associated with commitment to a plan of action and health promoting behavior (Pender et al., 2001).

Application to The Proposed Study

Lari, Tahmasebi, and Noroozi (2017) have supported the effectiveness of utilizing Pender's HPM to explain health promoting behaviors of persons with chronic illnesses such as diabetes. Lari et al. (2017) conducted a randomized control trial (RCT) in Iran to identify the effectiveness of an electronic education program on physical activity in patients with DM. A total of 80 eligible participants were recruited and assigned to a control (n=40) or an intervention group (n = 40). The inclusion criteria were ability to read and write, no diabetic foot ulcers, and diagnosed with diabetes for one or more years previously (Lari et al., 2017).

The content of the education program was based on the HPM. Participants in the intervention group were given an educational compact disc (CD) that included chapters about the benefits and barriers of physical activity, and step-by-step physical activity trainings that

gradually increased in intensity over a 3-month period. Family and friends of the participants were also given another educational CD. The study outcomes measures were assessed at baseline, two weeks, and three weeks after the program (Lari et al., 2017).

A total of 76 participants (n = 40 intervention group and n = 36 in control group) completed the study. The intervention program was significantly associated with higher perceived self-efficacy ($p < 0.001$), health status ($p = 0.032$), benefits ($p < 0.001$), friends support ($p < 0.001$), and lower perceived of barrier of physical activity ($p < 0.001$; Lari et al., 2017). Also, there was a significant difference in average of metabolic equivalent of task in the intervention group compared to the control group ($p < 0.001$). The program positively changed participants' beliefs, consequently, promoting their health behaviors (Lari et al., 2017). The results of the study are consistent with the HPM in that perceived self-efficacy, benefits, barriers, and the presence of social support influence the health promotion behavior (Pender et al., 2006).

Statement of the Purpose

The purpose of this proposed study will be to evaluate the effectiveness of a home-based, internet-delivered exercise intervention to decrease fasting plasma glucose and body mass index, and to increase level of physical activity in Saudi women with DM.

The proposed study will use the HPM as theoretical framework for the purpose of promoting physical activity and, consequently, health outcomes in Saudi women with DM. A home-based physical activity program will be designed and evaluated. The concepts of perceived self-efficacy, barriers to action, and health promotion behavior will be measured (See Figure 2).

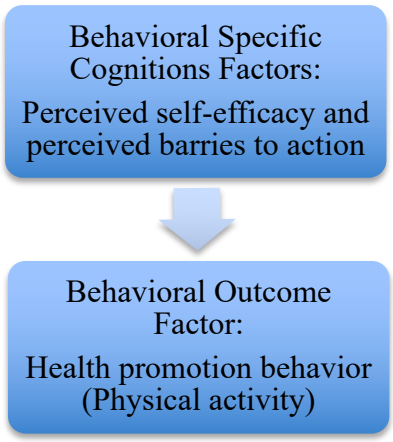


Figure 2: Health Promotion Model Concepts

The activity related affect in the HPM explains that the more individuals expect positive outcomes of an activity, the more the likely they are to engage in that activity (Pender et al., 2006). It also can directly provoke the person to sustain the activity, and can indirectly result in self-efficacy and a commitment to an action plan (Pender et al., 2006). As mentioned previously, physical activity generates various positive health outcomes for adults with diabetes (Cugusi et al., 2015; Myers et al., 2013; Sung & Bae, 2012). Thus, the researcher hopes that participants who engage in the proposed home-based physical activity program will sustain that activity over time as a result of its positive outcomes. Based on the HPM, the researcher also expects that participants in the program will have higher levels of perceived self-efficacy and lower perceived barriers of physical activity.

Statement of Question

What is the effect of a home-based, internet-delivered exercise intervention on fasting plasma glucose, body mass index, and level of physical activity among Saudi women with DM?

Assumptions

1. Saudi women with DM have the potential to engage in regular physical activity.

2. A majority of Saudi women have access to a smart phone or portable electronic device that can access the internet.
3. Saudi women are more likely to engage in a physical activity program that can be done at home, due to cultural factors of transportation and women's roles in society.
4. Saudi women are more likely to engage in a home-based physical activity program due to cultural restriction of outdoor clothing.

Chapter Summary

In conclusion, uncontrolled DM can have devastating impacts on an individual's health outcomes. Diabetes can lead to serious health problems such as DKD, diabetic retinopathy, diabetic neuropathy, coronary artery disease, peripheral arterial disease, and stroke (Fowler, 2008; 2011). Typical treatment plan for DM involves a pharmacological therapy and lifestyle modifications, including healthy diet and physical activity (ADA, 2017b). Engaging in regular physical activity has been associated with improvement in BG, thus, improving diabetes outcomes (Cugusi et al., 2015; Myers et al., 2013; Sung & Bae, 2012). Based on the research perfomed to date, there is a great need for a home-based exercise intervention to improve the level of physical activity among Saudi women with diabetic. The purpose of this proposed study will be to evaluate the effectiveness of a home-based, internet delivered exercise intervention to decrease FPG and BMI, and to increase level of physical activity in Saudi women with DM.

Chapter II

CRITICAL REVIEW OF RELEVANT LITERATURE

This chapter includes a discussion of the relevant literature of the problem of DM. It will also include a discussion of the recommended treatment for DM and the future physical activity DM research for Saudi women.

Prevalence of DM

In SA, there has been a dramatic increase in the prevalence of DM mainly due to rapid urbanization and industrialization that led people to adopt unhealthy lifestyles (Sherif & Sumpio, 2015). SA is ranked in the top 10 countries worldwide for the prevalence of DM, currently at 23.9% (IDF, 2013). The estimated prevalence of DM in Saudi women, aged 18 years and older, is as high as 11.4%, compared to 12.1% in Saudi men (Bahijri et al., 2016). Although the prevalence of diabetes is higher in Saudi men than women, women are 7.38 times more likely to have poor glycemic control than men (Mokabel et al., 2017). In addition, Saudi women often tend to be physically inactive. Researchers reported a prevalence of physical inactivity as high as 72.9% in women compared to 60.1% in men (Al-Zalabani et al., 2015).

In the SA population, the prevalence of DM increased with age. Bahrji et al. (2016) investigated the effect of age and sex on the prevalence of DM in the Saudi population. It was estimated that almost half of people aged ≥ 50 years had DM, whereas less than the half of people aged < 50 years had DM (Bahrji et al., 2016).

Complications of DM

Microvascular Complications

Uncontrolled DM can have devastating effects on individuals. Diabetes complications can be classified as microvascular and macrovascular (Fowler, 2011). Individuals with DM with

long duration of diabetes and poor glycemic control have higher risk of developing microvascular complications, including DKD, diabetic retinopathy, and diabetic neuropathy (Fowler, 2011). DKD is one of the most serious lifelong complications that can lead to premature death (Afkarian et al., 2013). It is characterized by an estimated glomerular filtration rate of < 60ml/min/1.73 m^2 (Tuttle et al., 2014).

Higher levels of HbA_{1c} are strongly associated with the development of DKD (Bash et al., 2008). HbA_{1c} values of 6% -7%, 7% -8%, and greater than 8% are associated with developing DKD 1.4 (95% CIs: 0.97-1.91), 2.5 (1.70-3.66), and 3.7(2.76-4.90) times, respectively, compared to HbA_{1c} values of less than 6% ($p < 0.001$; Bash et al., 2008). This supports the importance of controlling HbA_{1C} in people with DM.

Diabetic retinopathy is characterized by damaged blood vessels in the retina and can lead to loss of vision (ADA, 2017a; Fowler, 2011; National Eye Institute, 2015). Diabetic retinopathy is a very common condition among adults with DM; the estimated prevalence of retinopathy among Saudi patients with DM is as high as 14% (Alaboud et al., 2016).

Individuals with DM can also develop DN as a result of poor glycemic control (Pop-Busui et al., 2017). DN is a nerve damage disorder that can affect any organ system (NIDDK, 2013). In SA, researchers have estimated the prevalence of DN among patients with DM to be as high as 5.6% (Alaboud et al., 2016). DN can be painful and thus negatively affect peoples' quality of life (Singh et al., 2014). It is a risk factor for amputation of the lower extremities (Jeon et al., 2016).

Most adults with DM can reduce their risk of microvascular diseases through achieving optimal glycemic control (Skyler et al., 2009). The American Diabetic Association has

highlighted the importance of maintaining optimal glycemic control (HbA_{1C} < 7%) for reducing the risk of developing microvascular complications among DM patients (Skyler et al., 2009).

Macrovascular Complications

Diabetes macrovascular complications include coronary artery disease, peripheral arterial disease, and stroke (Fowler, 2008; Shah et al., 2015). Researchers have found that individuals with DM have a higher risk of developing peripheral arterial disease, ischemic stroke, stable angina, heart failure, and non-fatal myocardial infarction (hazard ratios of 2.98, 1.72, 1.62, and 1.56 with 95% CIs [2.76-3.22], [1.52-1.95], [1.49-1.77], [1.42-1.67], and [1.42-1.67], respectively) compared to individuals without DM (Shah et al., 2015). In addition to glycemic control, maintaining optimal cardiometabolic parameters can reduce the risk of macrovascular complications (Chawla et al., 2016).

Diabetes Economic Burden

Diabetes imposes a heavy economic burden on the Saudi healthcare system. In 2010, the estimated medical expenditures for people with DM were ten times higher than that of people without DM ($3,686 vs. $380; Alhowaish, 2013).

DM and its Risk Factors

The incidence of DM has been linked to non-modifiable (genetic) and modifiable (behavioral and environmental) risk factors (Colberg et al., 2010). Although the incidence of DM can be attributed to non-modifiable factors such as family history (Bianco et al., 2013), nearly 80% of the rise in the prevalence of DM is attributed to modifiable risk factors (WHO, 2015). These modifiable risk factors include obesity, physical inactivity, and unhealthy dietary habits (WHO, 2015).

Obesity

Obesity among adults is characterized by a body mass index (BMI) of 30 kg/m^2 or higher (WHO, 2018d). High BMI is strongly associated with the risk of developing DM (Ganz et al., 2014). Individuals who are overweight or obese are 1.5-5 times as likely to develop DM than those with normal BMI (Ganz et al., 2014). In SA, the estimated prevalence of obesity in women is 33.5% compared to 24.1% in men (Memish et al., 2014).

Physical Inactivity

Individuals who are physically inactive are more likely to develop DM (WHO, 2015). According to Joseph et al. (2016), diabetes risk is lower in individuals who are engaging in brisk or striding walking pace (> 4mph) compared to those with none or causal walking pace (< 2mph; HR 0.67; 95% CI: 0.54-0.84). In the European Region, it is estimated that physical inactivity contributes to 7% of the prevalence of DM (WHO, 2015).

In SA, researchers reported a prevalence of physical inactivity as high as 72.9% in women compared to 60.1% in men (Al-Zalabani et al., 2015). The high prevalence of physical inactivity among Saudi women could be attributed to several factors including the scarcity of women's exercise facilities (Samara et al., 2015). In addition, Saudi women are more likely to adopt a sedentary lifestyle due to cultural limitations. In SA, women cannot drive themselves to parks or gyms; they are required to have men drive them everywhere. When women are in public, they are expected to wear an Abayah, which is a full-length robe, that makes it difficult for women to engage in different kinds of outdoor exercise. Walking is a convenient form of outdoor exercise, but most Saudi Arabian neighborhoods lack safe sidewalks. Recently, a man lost his life while exercising in one of the major streets in Qatif city, SA. In another neighborhood, a girl was walking on the street when a car hit her, causing severe injuries. Due

to recent changes in SA law, SA women are starting to drive, but this is a new cultural phenomena that has not yet affected physical activity in women with DM.

Unhealthy Eating Habits

Unhealthy eating habits have been associated with an increased risk of developing DM (WHO, 2015). Mohamed et al. (2013) found that approximately 59.9% of diabetic Saudis consumed three meals per day, 53.1% did not use sugar, 69.8% used artificial sweetener, 81.5% did not eat adequate fruits and vegetables, 12% did not include any fruits and vegetables in their meals, 48.6% ate dates, and 78.8% did not adhere to dietitian visits (Mohamed et al., 2013. There were no significant differences in dietary habits between males and females. The results of this study indicate that Saudi adults with DM have unhealthy dietary practices (Mohamed et al., 2013).

Recommended Treatment for DM

Although DM is incurable, researchers continue to affirm that to prevent or delay the onset of DM complications, maintaining optimal levels of BG, lipids, and blood pressure is fundamental (ADA, 2017b). For most nonpregnant adults with diabetes, the recommended glycemic goals are $HbA_{1C} < 7\%$, FPG range between 80 – 130 mg/dL, and not more than 180 mg/dL 1 -2 hrs. after meals (ADA, 2018). To achieve these goals, health care providers should customize the treatment plan to each patient. Typically, DM treatment plans involve pharmacological therapy and lifestyle modifications, including a healthy diet and physical activity (ADA, 2017b). Indeed, it is important that a treatment plan produces a clinically significant reduction in the HbA_{1C}. Researchers have concluded that a 0.3% reduction in the HbA_{1C} is considered to be clinically significant (Cradock et al., 2017).

Pharmacological Therapy

Metformin monotherapy is the initial pharmacological therapy for DM patients unless the patient's HbA_{1C} is ≥ 9%. In that case, the healthcare provider should consider dual or triple therapy (ADA, 2017b). Metformin is an antihyperglycemic drug used to lower BG concentration in DM individuals who are overweight or obese and with normal kidney function (Song, 2016). It is one of the safest antihyperglycemic drugs. The main effect of metformin is that it reduces the hepatic glucose production and improves the peripheral insulin sensitivity without increasing insulin production. It thus does not cause hypoglycemia (Song, 2016). The maximum approved dose of metformin for diabetic patients is 2.5 g (35 mg/Kg) per day (He & Wondisford, 2015).

Healthy Diet

A healthy diet is an important component of diabetes management to promote healthy outcomes (ADA, 2017b). Researchers have evaluated the effectiveness of different dietary approaches on diabetic patients' health outcomes (Andrews et al., 2011; Coppell et al., 2010). Results from RCTs of dietary programs have demonstrated significant improvement in both HbA_{1C} and BMI, but not in cardiovascular status, in patients with DM (Andrews et al., 2011; Coppell et al., 2010).

Andrews et al. (2011), in England, and Coppell et al. (2010), in New Zealand, conducted RCTs to evaluate the effectiveness of dietary interventions on glycemic control in patients with DM. The samples sizes were 593 and 94 participants respectively (Andrews et al. 2011; Coppell et al., 2010). Andrews et al. (2011) inclusion criteria were adults aged 30-80 years who were diagnosed with DM within five to eight months of the beginning of the study with $HbA_{1C} \leq 10$. On the other hand, in Coppell et al.'s (2010) study, the participants were from various ethnic

backgrounds, less than 70 years old, and had persistent poor glycemic control (HbA_{1C} >7.0%) despite taking prescribed oral hypoglycemic medications. They also had at least had two of the following conditions: obesity or overweight, hypertension, or dyslipidemia.

In Andrews' et al. (2011) intervention program, initially participants in the intensive diet intervention group met with a dietitian for an hour of individualized diet education and goal setting. This was followed by a 30-minute session, every three months for 12 months, and participants attended 30-minute appointments every six weeks held by the study nurses to reinforce the dietary advice and goal setting. Similarly, in the Coppell et al. (2010) intervention program, the participants received a total of seven dietary education sessions with the study dietitian. Both interventions focused on consuming appropriate food quantities and choosing foods with low sugar that are also low in calorie and fat content (Andrews et al., 2011; Coppell et al., 2010).

In the Andrews et al. (2011) study, following six months of intervention, there was a significant decrease in the mean of HbA_{1C} in the diet group (-0.28%, 95% CI -0.46 to -0.10; p = 0.005) compared to the usual care group. At 12 months, the differences in the HbA_{1C} remained the same. Similarly, in the Coppell et al. (2010) study, following six months of intervention, there was significant weight reduction (-1.3 kg; p = 0.032), decreased BMI (-0.5; p = 0.026), HbA_{1C} (-0.4%; p = 0.007), decreased waist circumference (-1.6 cm; p = 0.005), decreased saturated fat (1.9% total energy; p = 0.006), and increased protein (1.6% total energy; p = 0.045) in the intervention compared to the control group.

The previous interventions could be applied to health care settings in SA with some limitations. The numbers of sessions required is a reasonable amount and would not be overly inconvenient for patients. Because Saudi Arabia's government offers free healthcare services for

Saudi citizens (Almalki et al., 2011), there would be no expenditure to the participants for either program; however, these programs might be costly for the government to implement. The most convenient place to implement these programs in SA would be the primary care centers located in each neighborhood, but most of these centers do not have dietitians. The SA Ministry of Health would need to establish new policies and hire and train more dietitians to implement such programs.

Physical Activity

Physical activity is the cornerstone of managing DM due to its positive impact on insulin sensitivity (Balkau et al., 2008; Colberg et al., 2010). Researchers have demonstrated that engaging in regular physical activity is associated with various positive health outcomes in people with DM, such as improvement in biochemical parameters including HbA_{1C} (Sanghani et al., 2013; Vaishali et al., 2012) and cardiometabolic parameters (Cugusi et al., 2015; Vaishali et al., 2012). For optimal health outcomes, individuals with DM should engage in at least 150 minutes per week of moderate or higher intensity aerobic exercise (Colberg et al., 2010).

Aerobic exercises include walking briskly, jogging, dancing, swimming, biking, climbing stairs at work, and playing sports such as tennis, basketball, soccer or racquetball (AHA, 2018). Intensity of physical activity is "the rate at which the activity is being performed or the magnitude of the effort required to perform an activity or exercise" (WHO, 2019, para.1). A metabolic equivalent of task (MET) is a unit used to express the intensity of physical activity. It is defined as the proportion of a person's rate of consumed energy during an activity to the person's rate of consumed energy while at rest (USDHHS., 2018). Moderate intensity exercise is defined as activities that involve a moderate amount of energy expenditure that leads to increased heart rate, approximately 3-6 METs (WHO, 2019). Walking at 3.0 miles per hour

(mph) consumes up to 3.5 METs of energy, thus it represents a moderate-intensity activity (USDHHS, 2018).

Programs supervised by trainers. In India, Sanghani et al. (2013) and Vaishali et al. (2012) conducted RCTs aimed to examine the impact of exercise programs on biochemical and cardiometabolic parameters among individuals with DM. Sample sizes were 279 and 57 participants respectively. Both studies included male or female participants who were physically inactive. In addition, Sanghani et al. (2013) inclusion criteria were that participants were age 30-60 years old, had been diagnosed with DM within one year, and had $HbA_{1C} \geq 6.5\%$, whereas the Vaishali et al. (2012) inclusion criteria were that participants were age 60 years and older, diagnosed with DM for more than 15 years, and had at least one of the cardio-metabolic risk factors: impaired FPG, prehypertension, overweight, or high cholesterol.

The Sanghani et al. (2013) intervention consisted of individualized and planned aerobic and resistance exercise supervised by a professional trainer and physiotherapist, meeting at a gymnasium. Participants were required to perform 45 minutes of exercise six times per week for six months. On the other hand, the Vaishali et al. (2012) intervention consisted of 12 weeks of individualized and supervised sequences of yoga sessions, including poses (asanas) and breathing techniques (pranayama). The yoga sessions took place at a hospital. Each session lasted for 40-60 minutes six times per week.

Following six months of structured activity, there was significant mean decline in the $HbA_{1C,}$ in the intervention compared to the control group ($p = 0.030$; Sanghani et al.'s (2013). However, there were no significant differences in blood pressure, total cholesterol, high-density lipoprotein, and low-density lipoprotein within or between the groups. On the other hand, in Vaishali et al.'s (2012) yoga program, following 12 weeks of intervention, there were significant

mean declines in HbA_{1C} (from 10.28% to 9.12%), FPG level (from 163.45 mg/dl to 115.62 mg/dl), total cholesterol (from 234.45 mg/dl to 200.25 mg/dl), triglycerides (from 169.74 mg/dl to 151.14 mg/dl), and low density lipoprotein (from 152.18 mg/dl to 131.14 mg/dl) and an increase in high density lipoprotein (from 35.85 mg/dl to 41.70 mg/dl) in the yoga group compared to the control group ($p < 0.05$). The decreases in HbA_{1C} in both of these studies are clinically significant when considering that a decrease in HbA_{1C} of between 0.3% and 0.5% is considered to be clinically meaningful (Cradock et al., 2017).

The previous interventions have some limitations if applied in SA. Although both programs could be offered for free to participants, engaging in an exercise program six times per week might not be convenient for most Saudi women. Most of the women in SA have other commitments with their husbands, children, and household work; thus, it might be difficult for them to participate in such an intensive program. In addition, these programs require a professional trainer and physiotherapists to supervise the exercise. The primary care centers in SA lack the equipment and staff necessary for this function; therefore, implementing such programs would be costly for the government.

Programs using home visits. A home-based exercise program would not require participants to attend supervised sessions. For example, a researcher in Turkey evaluated the effectiveness of a home-visitation program on exercise behavior in women with DM (Şekerci, 2017). A total of 63 women aged 20-49 years were recruited by convenience sampling and assigned to either an intervention or a control group. The program involved seven home visits at one-month intervals over a six-month period by a research nurse. The researcher created an exercise habit-gaining guide that provided the participants with more knowledge about exercise. The guide also provided the participants with information about when and how to exercise and

different types of exercise (Şekerci, 2017). The educational and counseling content of the program emphasized establishing and implementing individualized exercise plans. Following six months of the intervention, there were significantly greater improvements in participants' exercise knowledge, exercise self-efficacy, exercise duration, fasting glucose (0.33%), and non-fasting glucose (0.12%), and reduction in HbA_{1C} (0.16%) in the intervention compared to control group ($p < 0.05$; Şekerci, 2017).

The previous intervention has some limitations. Although the result reflected statistically significant decreases in the HbA_{1C}, 0.16% decrease is not considered clinically significant (Cradock et al., 2017). In addition, home visitation programs might make Saudi women uncomfortable due to their conservative culture.

Internet-based Exercise Programs

Another category of intervention would be online or technology-based programs. For example, Akinci et al. (2018), in Turkey, conducted a RCT to compare the effects of Internet based exercise with supervised exercise group on glycemic control, lipid profile, body composition, functional capacity, physical activity levels, and quality of life in diabetic adults. The sample size was 65 participants (47 women/18 men). Inclusion criteria were adults aged 40-65 years who were diagnosed with DM for at least one year, had HbA1c values between 6.5% to 11%, ability to walk for 420m in a six-minute walking test, had access to high speed Internet connection, and spoke Turkish language (Akinci et al., 2018).

In the Internet based exercise group, participants were provided with exercise online videos involving aerobic and resistance exercises. Participants were required to attend three days of exercise sessions per week for eight weeks. There were significant improvements in the HbA_{1C} (-0.91%, -0.8%; $p = 0.003$), FPG (-35.4, -39.45; $p = 0.009$), number of steps (1258.05,

1298.67; $p = 0.02$), six minute walking distance (30.5, 29.32; $p = 0.01$), waist circumferences (-5.64, -4.23; $p = 0.006$), hip circumferences (-1.31, -2.7; $p = 0.01$), and quality of life in the Internet based exercise and supervised exercise groups, respectively, compared to control group. However, only the Internet based exercise group had significant improvement in the lipid profile ($p = 0.2$; Akinci et al., 2018).

The previous intervention could be applied in S.A. with relatively few limitations. S.A. has begun using social networking applications, such as WhatsApp messenger in their official settings. For example, schools inform parents of children's absences through WhatsApp. Since most people have smartphones and most homes are outfitted with broadband, high speed Internet, an internet-based exercise intervention would be convenient and accessible to the majority of adults with DM.

Future Physical Activity DM Research for SA Women

Given the fact that women in SA with DM have more obesity but lower levels of physical activity compared to men, and have additional cultural barriers to physical activity, new interventions are needed. Home-based interventions would be ideal as the women would not need to rely on transportation to a gymnasium or park for exercise. Home-based interventions would also be relatively low-cost, for both the patient and the SA healthcare system. Technology could be used in the home, such as an exercise DVD or an online exercise program (e.g. YouTube video) that could be accessed by computer or smartphone.

No studies were found in which researchers tested an exercise intervention in Saudi women with DM delivered at home using the Internet. The purpose of this proposed study will be to evaluate the effectiveness of a home-based, internet-delivered exercise intervention to decrease FPG and BMI, and to increase level of physical activity in Saudi women with DM.

Using WhatsApp, a YouTube link will be sent to the participants. The YouTube video will contain different types of aerobic exercise. Participants will be required to attend five days of exercise sessions per week for 12 weeks. Each exercise session should last at least 30 minutes. The study investigator will conduct a motivational phone call every other week to encourage adherence to the intervention.

Chapter Summary

A striking prevalence of physical inactivity has been reported among women with DM in S.A. According to Bahirji et al. (2016), about 71.3% of women in SA are physically inactive or engage in less than an hour per week of planned physical activity. According to the research that has been performed to date, there is a great need to evaluate the effectiveness of a home-based exercise intervention among Saudi women with DM. No studies were found in which researchers tested an exercise intervention in Saudi women with DM delivered at home using the Internet. The purpose of this proposed study will be to evaluate the effectiveness of a home-based, internet-delivered exercise intervention to decrease FPG and BMI, and to increase level of physical activity in Saudi women with DM.

Chapter III

METHODS AND PROCEDURES

This chapter includes a discussion of the methods that was applied in this study. Research design, identification of sample, description of setting, measurement methods, procedure, ethical consideration, data analysis, and delimitation are presented. The purpose of this proposed study was to evaluate the effectiveness of a home-based, internet-delivered exercise intervention to decrease FPG and BMI, and to increase level of physical activity in Saudi women with DM.

Research Design

This was a pilot feasibility study of an exercise intervention in Saudi women with DM. The purpose of this study was to evaluate the feasibility of a home-based, internet-delivered exercise intervention in Saudi women with DM. A one-group pretest-posttest design was used to address the research question (Gliner et al., 2017). The main reason this was a feasibility study with a small sample was that we did not know how Saudi women would react to this technology-centered intervention at home. Pilot studies are useful in assessing the feasibility and acceptability of an intervention (Grove et al., 2016). To our knowledge, there had not been a study among diabetic Saudi women in which a technology-centered intervention was applied. Since the participants responded positively to the intervention, it can be replicated with a fully powered sample in the future.

Upon recruitment, participants were measured (pre-test), and again after week 8 (post-test). The independent variable was the home-based, internet-delivered exercise intervention. The dependent variables were physical activity, FPG, body mass index (BMI), and the participant's opinion of the intervention's efficacy.

Identification of Sample

Because this was a pilot intervention, there was a one-group convenience sample of 20 women. Findings from this study will assist the PI in calculating the sample size needed to find significance in future studies.

Inclusion Criteria

The inclusion criteria for this study were self-identified Saudi females, above 18 years of age, diagnosed with DM, who had a computer or smart phone device that could access the internet at home. The exclusion criterion, by self-report, was the presence of any diseases or physical limitations that would have prevented simple, at home physical activity, such as uncontrolled hypertension, unstable retinopathy, foot or ankle injury, or lack of feeling in their feet (neuropathy).

Data Collection

Data was collected before the 8-week intervention, including demographic data, height, weight, FPG, and level of physical activity. After the 8 weeks, data collection included repeating the baseline data and opinions of the exercise intervention (See Appendix A)

Power and Sample Size Considerations

Statistical power for evaluation of this study's objectives was calculated using the software package, G*Power version 3.1.9.4 (Faul et al., 2009). This pilot study enrolled 20 participants. The alpha level used for this analysis was $\alpha < 0.05$. The power analysis revealed the statistical power for this study was 0.14 for detecting a small effect, 0.56 for detecting a medium effect, and 0.92 for the detection of large effect. The power analysis test revealed that there was adequate power at the large effect size level, but less than adequate statistical power at

the medium and small effect size level. The following table displays the statistical power based on possible effect sizes with an N of 20.

Table 1: Effect Size and Statistical Power for N=20

Effect Size	**Small**			**Medium**			**Large**
Cohen's d_z	.20	.30	.40	.50	.60	.70	.80
Statistical Power (1-*b)*	.14	.25	.39	.56	.72	.84	.92

Measurement Methods

Demographic Data

The demographic variables were age, marital status, and level of education (See Appendix B).

Physical Activity

Physical activity was measured using a step counter tool. Steps have been identified as "a basic unit of locomotion and provides an easy metric of ambulation" (USDHHS, 2018, p. 111). Setting a target of 10,000 steps per day is one way of promoting individuals' health (USDHHS, 2018). In this study, the smartphone application StepsApp was used to measure step counts as a reflection of physical activity (See Appendix C).

Presset et al. (2018) compared the accuracy of the Apple iPhone application, RUN, and the mechanical pedometer, YAM, with the treadmill data. Inclusion criteria were adults without walking difficulties, chronic diseases, acute disease, prosthesis, or electronic medical devices (Presset et al., 2018). Participants were required to wear the iPhone at 3 different positions (belt, arm, jacket), and the pedometer at the waist. In addition, participants were asked to walk on a

treadmill at different speeds (2, 4 and 6 km/h). Each walking session lasted for 4 minutes and 50 seconds. The number of steps acquired by RUN application was more accurate than the YAM pedometer at 2 km/h ($p < 0.05$) and at 4 km/h ($p = 0.03$), compared to the treadmill data. The step counting of RUN application was more accurate when the iPhone was strapped to the arm (Presset et al., 2018).

Fasting Plasma Glucose

The FPG was measured using the Accu-Chek Performa BG test system (See Appendix D). Kermani et al. (2017) evaluated the performance of Accu-Chek test system against the laboratory technique, a standard measurement of BG. There was a positive correlation between the Accu-check system and the standard measurement of BG ($r = 0.876$, $p < 0.001$). The result indicated acceptable accuracy of the Accu-Chek test system (Kermani et al., 2017).

Anthropometric Parameters

Body weight and height were measured with a Detecto mechanical scale (439 Eye-Level Beam Scale with Height Rod). The calibration procedure of this scale includes moving the screw shaped metal on the left until the needle on the right side of scale is in the middle position. The calibration procedure was done once a day. BMI was calculated by the following equation: BMI = Body weight in kilograms^2 / Height in meters^2. See Table 2 for

Opinion of the Efficacy of the Intervention

Since this was a new intervention that had not been tested, at the end of the eight weeks the participants were asked some open-ended questions about their opinion of the intervention (See measures in Appendix E). In order to refine this intervention, or design new ones, researchers need to know the opinion of typical Saudi woman with DM (See Table 2 for the Key Variables Conceptual and Operational definition, and Level of Measurement).

Table 2: Key Variables Conceptual and Operational Definition, and Level of Measurement

Variable	Conceptual definition	Operational definition	Level of Measurement
Physical activity	The use of muscles and energy to move the body (WHO, 2018c)	StepsApp (smartphone application)	Ratio
FPG	A blood test which reflects fasting plasma glucose levels (ADA, 2019)	Accu-Chek Performa glucometer for fasting plasma glucose	Ratio
Anthropometric parameters (BMI)	Measures adults' health and nutritional condition (WHO, 2019)	Detecto mechanical scale for BMI	Ratio
Opinion of the efficacy of the intervention	Participants qualitative opinion about the usefulness of an online-based exercise intervention at home	Questionnaire created by the PI	Qualitative

Study Setting

The study was conducted in Qatif city, located in the Eastern region of Saudi Arabia. A convenience sample was recruited from three primary health care (PHC) centers located in Qatif city; Sanabis, Mahdoud, and Monira PHC centers. These PHC centers are governmental facilities in which care is provided free of cost to the Saudi patients. On average, each PHC center serves about 400 diabetic patients per month, so recruiting a sample from these centers was possible.

Intervention

A YouTube link was sent to the participants through WhatsApp. Participants had the choice to play the YouTube video on a smart television, iPad, or smart phone. The YouTube video contains moderate intensity exercises that were created by Leslie Sansone, a certified fitness expert (Walkathome, n.d). It includes a three-mile brisk walking activity, which is 45:35 minutes long. The activity in the video can be safely done at home without using any additional exercise tools. It starts with warm up walking exercise for five minutes, increases the intensity

gradually to a brisk walk for 35 minutes, and then ends with five minutes cool down walking exercise. The walking activity includes walking in place, side steps, kicks, forward and backward, knee lifting, forward back walks, and arm exercises; reaching up and down, push and bring it back, open and close. The PI ensured that each participant turned on the Arabic subtitles in the video. Participants were also asked to do five exercise sessions per week for 8 weeks, or 40 sessions total. Each exercise session lasted at least 30 minutes, for a total of 150 minutes per week (Sansone, 2014).

The PI conducted a motivational phone call every other week (5 times total) to encourage adherence to the intervention. Each phone call lasted 5 to 10 minutes (See Motivational Phone Call; Appendix F).

Procedures

1. The PI approached women in the waiting room of the three Al-Qatif PHC centers, and handed out a questionnaire to screen interested subjects with DM to approach the PI (See recruitment script; Appendix G).
2. Those who qualified and were interested in participation were taken to a private room in the health center where the PI described the study in more detail.
3. If the participant met the inclusion criteria, the PI obtained signed informed consent (See Appendix H).
4. Participants were asked to provide their phone numbers to send them the YouTube link via WhatsApp. If they did not have WhatsApp, the link was sent through a regular text message.
5. The PI prepared the following equipment at the clinic to obtain FPG: the Accu-Chek Performa BG test system, test strips, sterile single-use lancing devices, alcohol swabs,

disposable gloves, hand sanitizer solution, and cotton wool/gauze, and sharp container. Pre-intervention data collection was performed: demographics, height, weight, and FPG. If participants had been fasting for at least 8 hours, the blood sample was obtained immediately. If not, participants were asked to come back another day to measure their FPG. Participants were asked to sit down and informed that they would feel a little pain during the finger prick. The finger was cleaned with alcohol, then pricked with a single use lancet to obtain a drop of blood for the glucose monitor. Cotton wool was placed over the puncture site after the sample was obtained, and the participant was told to put pressure on the site until bleeding stopped. This lasted about 30 minutes to complete.

6. The PI performed a control test to the Accu-Chek meter when opening a new test strip box to ensure that the meter worked properly.
7. The PI cleaned the meter after each patient use with a soft cloth moistened with 70% isopropyl alcohol.
8. All intervention procedures were explained to participants.
9. The PI presented a short teaching session (10 minutes) containing information about the type and benefits of exercise, the importance of warming up before starting exercise sessions, and general guidelines for safe physical activity (See Appendix I). This information also was sent home with them in writing. No stress tests were needed for asymptomatic patients with very small risk for cardiovascular disease (Marwick et al., 2009).
10. The PI installed the Steps application on the subjects' device, and then made sure to allow the application to access participants motion and fitness activity.

11. A running belt bag was distributed for each participant. Participants were asked to attach the belt to their arm during the day. Placing the iPhone close to the body can increase the accuracy of the iPhone step tracker applications (Presset et al., 2018). The bag held their device to count their steps while exercising. Sleeping and aquatic activities such as showering were excluded.
12. Before starting the intervention, participants were asked to measure and record their daily steps for three days (See Appendix J). Participants were required to keep a diary for the total daily steps count for the entire intervention period.
13. When they returned to the health center, the PI collected the same data as at baseline, and added qualitative questions about their opinion of the exercises. Post-test data collection lasted for 60 minutes.

Presentation of Ethical Consideration

Permission to conduct this study was obtained from the Ministry of Health Institute Review Board (IRB). Permission to recruit subjects was obtained from the directors of the primary health care centers. The PI ensured the participants' confidentiality and privacy during and after the study. The PI de-identified all identifiable information and the data was kept in a password-protected computer.

There was no anticipated serious physical or emotional harm to the participants in this study. There was only a very minimum risk of muscle or joint injury due to initiating exercise. Ensuring that each participant was following the exercise guidelines, starting slowly and increasing intensity and duration gradually, eliminated the risk. No study participant reported physical injury during this intervention.

Data Analysis

Data was analyzed using the statistical software program, SPSS 23.0. Descriptive statistics were calculated to describe each variable; mean, range, and SD. To test changes from Time 1 to Time 2, paired samples t-tests were computed. The paired t-test was appropriate when comparing two population means (Grove & Cipher, 2020). To analyze the participants' response of the efficacy of the intervention, Morse's framework was utilized (Morse, 1994).

Variable	Level of Measurement	Statistical Test
Physical activity	Ratio	Paired samples t-test
FPG	Raito	Paired samples t-test
BMI	Ratio	Paired samples t-test
Opinion of the efficacy of the intervention	Qualitative/Ratio	Morse's (1994) framework/Descriptive

Study Delimitations

Delimitations of this study included the one group pretest-posttest design. In this design, the post-test scores may have been influenced by several factors such as maturation processes, pretest exposure, and changes in the instrumentation (Grove et al., 2016). A comparison group was not used in this study. A stronger study design would have included a control or comparison group, and subjects would be randomized to one group or the other to avoid sampling bias.

The sample size was small due to the intent to test the intervention. In future studies, samples should be larger and represent a larger area of the country rather than only one region of S.A.

Another delimitation of this study was the population being studied. Saudi males were not included in this study due to several reasons. The accessibility and availability of gyms in

S.A. is easier for males than females. In addition, there are no traditional clothes that restrict males' movement outdoors as there is with women in S.A.

Chapter IV

FINDINGS

The findings of the data analysis are described in this chapter. Descriptive statistics were calculated to describe each variable; mean, range, and SD. Paired samples t-tests were computed to test changes from Time 1 to Time 2. Shapiro-Wilk tests were computed to examine the dependent variables for normality.

Description of The Study Sample

A convenience sample of 20 participants was recruited from three PHC centers located in Qatif city. All 20 participants completed the home-based exercise intervention. Descriptive statistics of the sample are presented in Table 3. All 20 participants (100%) were Saudi females. Participants ranged in age from 44 to 63 with the majority between 50 and 59 (55%; M = 54.75, SD = 5.447). The majority were married (90%) and had at least an elementary school education (85%).

Variables	Categorical	Frequency (%)
Age (Grouping)	40-49	4 (20%)
	50-59	11 (55%)
	60+	5 (25%)
Education Level	Read and write	5 (25%)
	Elementary	7 (35%)
	Middle School	4 (20%)
	High School	2 (20%)
	College	2 (10%)
Marital Status	Married	18 (90%)
	Widow	1 (5%)
	Divorced	1 (5%)

Table 3: Demographic Variables

First Research Question: Is there a difference between Time 1 to Time 2 in the participants'

average number of steps?

To address the research question, Shapiro-Wilk test was computed to examine the dependent variable, number of steps, for normality. Results indicated non-significant results for both pre and post-test values (p = .193 and p = .732, respectively). Therefore, the assumption of normality was met for the dependent variable, number of steps. Paired samples t-test were computed to determine if there were statistically significant differences between pretest and posttest (See Table 4). Results indicated a significant increase in steps from Time 1 to Time 2, $t(19) = -2.21$, p = 0.04, $M = 5010.82$ (SD = 2905.01) to 5980.3 (SD = 2022.47) respectively.

Variables	Categorical	Mean ± Std	(Min, Max)	Range
Age (Numeric)	All Participants	54.75 ± 5.447	(44, 63)	19
Steps	Before	5010.82±2905.01	(1423, 12074)	10651
	After	5980.3±2022.47	(2453.07, 11221.43)	8768.35
FPG	Before	140.35±16.13	(100, 167)	67
	After	135.7±16.23	(95, 164)	69
BMI	Before	33.42±2.44	(29.5, 38.6)	9.1
	After	32.84±2.49	(29.3, 38.5)	9.2

Table 4: Change in Dependent Variables

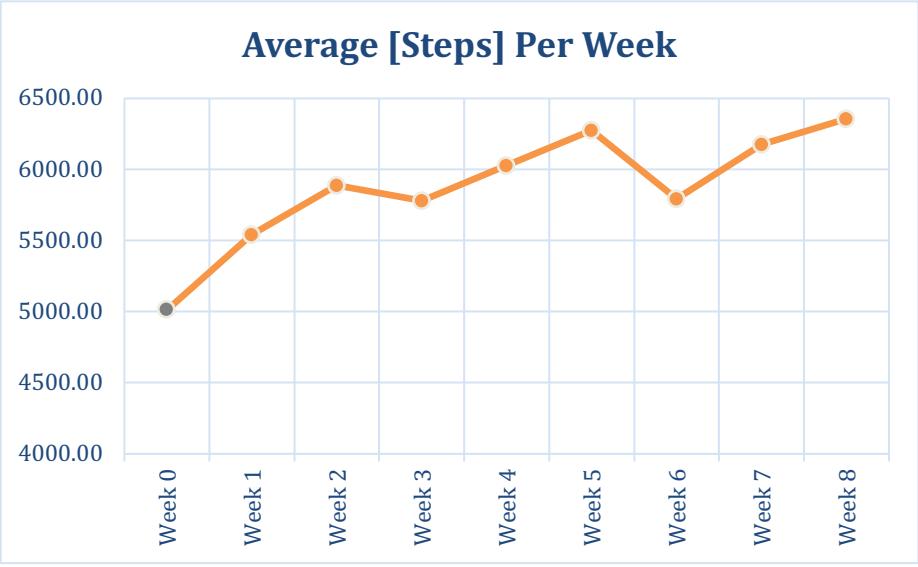


Figure 3: Mean Number of Steps Over Time

Second Research Question: Is there a difference between Time 1 to Time 2 in Fasting Plasma Glucose (FPG)?

To address the research question, Shapiro-Wilk test was computed to examine the dependent variable, FPG, for normality. Results indicated non-significant results for both pre and post-test values (p = .679 and p = .772, respectively). Therefore, the assumption of normality was met for the dependent variable, FPG. Paired sample t-test was computed to determine if there was a statistically significant difference between Time 1 to Time 2. Results indicated a significant decline in FPG from pre to post-test, $t(19) = 9.63$, $p < 0.001$, $M = 140.35$ (SD = 16.13) to 135.7 (SD = 16.23) respectively.

Third Research Question: Is there a difference between Time 1 to Time 2 for the averaged BMI results?

To address the research question, Shapiro-Wilk test was computed to examine the dependent variable, BMI, for normality. Results indicated non-significant results for both pre and post-test values (p = .853 and p = .483, respectively). Therefore, the assumption of normality was met for the dependent variable, BMI. Paired samples t-test was computed to determine if there was a statistically significant difference between Time 1 and Time 2. Results indicated a significant decline in BMI from pre- to post-test, $t(19) = 8.26$, $p < 0.001$ $M = 33.42$ (SD = 2.44) to 32.84 (SD = 2.49) respectively.

Opinion of the Efficacy of the Intervention

At the end of the eight weeks, the participants were asked some open and closed-ended questions about their opinion of the intervention. The closed-ended questions were categorized by 1-"Don't Like it", 2-"Like it", 3-"Like it a lot". Of the 20 participants, all 20 (100%) thought that the intervention was practical, they liked the video, and they said they would recommend it

to families and friends. Only 10% of the participants suggested a shorter video to make the intervention better.

The final question was open-ended and Morse's (1994) framework was used to analyze the data. Participants identified several barriers that prohibited them from doing the activity: lack of appropriate place, lack of fast internet connection, and lack of time.

Participants described barriers as, "It was hard to get a private room with TV and internet connection". "Sometimes the Internet connection gets really bad." In addition, participants described barriers to home-based physical activity by saying, "The exercise video was a great idea, but my problem is time management." "Also, the Internet connection was not good." "I like the home-based exercise, but sometimes I find it hard to find a time to do the activity."

Chapter Summary

The present pilot study aimed to evaluate the effectiveness of a home-based exercise intervention in Saudi women with DM. Descriptive statistics were computed to describe study variables: demographics, steps, FPG, and BMI. Paired samples t-tests were computed to address research questions. Findings from this study showed significant improvement in participants steps, FPG, and BMI. In addition, participants reported barriers of being physically inactive such as lack of appropriate place, fast internet connection, and time management.

Chapter V

DISCUSSION

The present study evaluated the effectiveness of a home-based, internet-delivered exercise intervention to decrease FPG and BMI and to increase the level of physical activity in Saudi women with DM. A one group pre-test/post-test design was utilized. A total of 20 participants were enrolled. Data collection was performed pre- and post-intervention. All participants completed the eight-week home-based exercise intervention. At the end of the eight weeks, participants were asked open and closed-ended questions about their opinion of the intervention. This chapter includes the interpretation of the major findings and how these findings relate to other studies of physical activity in adults with diabetes. Clinical implications and implications for future research will also be discussed.

Interpretation of the Findings

The result of the paired samples t-test showed a significant improvement in the number of participants' steps (969.48; $p = 0.040$), FPG (-4.65 points; $p = 0.001$), and BMI (-0.59 points; $p = 0.001$). Similar results have been reported by Akinci et al. (2018) in Turkey among adults with DM. They found a significant increase in participants' steps and reduction in FPG after an internet-based exercise program. Similarly, Vaishali et al. (2012) in India reported similar findings. They found a significant improvement in FPG after individuals with DM completed an exercise intervention.

Another key finding of this study was the barriers to physical activity. Participants reported barriers such as lack of appropriate place, lack of fast internet connection, and lack of time. Similar results have been reported by Al-Kaabi et al. (2009) conducted in the United Arab

Emirates among adults with DM. Awadalla et al. (2014) reported similar barriers of physical activity among university students in Saudi Arabia.

While the amount of change was statistically significant for all three outcome measures, they were not all clinically important. A FPG reduction of 4.6 points is useful clinically, but a BMI reduction of less than one point is not. Participants' step increase of under one thousand steps per day is also not clinically important. To clinically improve step count and BMI, a longer and more rigorous physical activity program is needed with greater motivators for participants. With the current results showing that the intervention is not clinically important, additional measures must be added to increase participation, motivation, and rigor.

Clinical Implications

Findings from this study highlight the value of increasing the levels of physical activity of Saudi women with DM. It is the obligation of healthcare providers and nurses to raise patients' awareness of the importance of being physically active and offer interventions that will have positive health impacts. While the results of the proposed internet-based home exercise program were not clinically important, they were still positive. For this reason, encouragement from providers for internet-based interventions that patients can do at home could have long-term positive effects. Barriers such as societal norms, social pressure, safety concerns, and inconvenience are eliminated with home-based interventions.

Additionally, internet-based interventions are advantageous because of low cost to both the provider and the patient. Not only are home-based programs less expensive than gym memberships, they also take less preparation and do not require a commute. This saves women valuable time, which was one of the most prevalent barriers to exercise. Finally, privacy can be maintained at home. Psychological pressure in the form of concern for the opinion of others and

self-consciousness can be avoided when working out at home. Therefore, all providers who care for Saudi women with DM should be recommending these cost-effective and convenient physical activity programs as part of their primary health care.

In order to support such efforts, incentives should be provided to women with DM who consistently participate in internet-based home exercise programs. One incentive would be internet speed upgrades. In order for exercise programs to stream smoothly, ample bandwidth is needed. Such exercise programs should remain free of cost to participants and a badging system should be implemented to gamify the process and add a dimension of fun, competition, and community to the routine.

Implications for Future Research

This study has shown that there is a great need for culturally appropriate physical activity programs for Saudi women with DM. Further studies with larger sample sizes are needed to evaluate the effectiveness of physical activity programs. Findings from this study will assist the PI in calculating the sample size needed to find significance in future studies. This study was a one-group design, but a comparison or control group would strengthen the results.

To verify the efficacy of internet-based interventions, additional outcome measures are needed for physical activity, such as the 6-minute walk test or muscle strength measures. Since BMI only decreased slightly, longer interventions need to be tested to see if a reduction in BMI is possible or clinically relevant. It could be that improved physical activity and reduced blood glucose are sufficient to improve health with or without weight reduction.

Future interventions must include added sources of motivation for physical activity for Saudi women with DM. Improved internet connections, activity groups for women to exercise

together, and badging systems to gamify the process might all improve program adherence and clinical outcomes.

Conclusion

The purpose of this study was to evaluate the effectiveness of a home-based, internet-delivered exercise intervention to decrease fasting plasma glucose and body mass index, and to increase level of physical activity in Saudi women with DM. Findings from this study highlighted the importance of increasing the level of physical activity of Saudi women with DM. This internet-based home exercise program for women with DM is promising and merits further study. Further research with larger sample sizes are needed to evaluate the effectiveness of physical activity programs. Conducting comparison or control group instead of one-group for future studies would strengthen the results. Findings from this study can assist the PI in calculating the sample size needed to find significance in future studies.

References

Afkarian, M., Sachs, M. C., Kestenbaum, B., Hirsch, I. B., Tuttle, K. R., Himmelfarb, J., & de Boer, I. H. (2013). Kidney disease and increased mortality risk in type 2 diabetes. *Journal of the American Society of Nephrology, 24*, 302-308. doi:10.1681/ASN.2012070718

Akinci, B., Yeldan, I., Satman, I., Dirican, A., & Ozdincler, A. R. (2018). The effects of Internet-based exercise compared with supervised group exercise in people with type 2 diabetes: A randomized controlled study. *Clinical Rehabilitation, 32*, 799-810. doi:10.1177/0269215518757052

Alaboud, mA., Tourkani, A., Alharbi, T., Alobikan, A., Abdelhay, O., Al Batal, S., . . . Mohammed, U. (2016). Microvascular and macrovascular complications of type 2 diabetic mellitus in central, kingdom of Saudi Arabia. *Saudi Medical Journal, 37*, 1408-1411. doi:10.15537/smj.2016.12.17062

Alhowaish, A. K. (2013). Economic costs of diabetes in Saudi Arabia. *Journal of Family and Community Medicine, 20*, 1-7. doi:10.4103/2230-8229.108174

Al-Kaabi, J., Al-Maskari, F., Saadi, H., Afandi, B., Parkar, H., & Nagelkerke, N. (2009). Physical activity and reported barriers to activity among type 2 diabetic patients in the United Arab Emirates. *The Review of Diabetic Studies, 6*(4), 271. Retrieved from https://www.soc-bdr.org/content/rds/

Almalki, M., Fitzgerald, G., & Clark, M. (2011). Health care system in Saudi Arabia: An overview. *Eastern Mediterranean Health Journal, 17*, 784-793. Retrieved from http://www.emro.who.int/index.html

Al-Zalabani, A. H., Al-Hamdan, N. A., & Saeed, A. A. (2015). The prevalence of physical activity and its socioeconomic correlates in Kingdom of Saudi Arabia: A cross-sectional population-based national survey. *Journal of Taibah University Medical Sciences, 10,* 208-215. doi:10.1016/j.jtumed.2014.11.001

American Diabetes Association. (2017a). Diabetic retinopathy: A position statement by the American Diabetes Association. *Diabetes Care, 40,* 412-418. doi:10.2337/dc16-2641

American Diabetes Association. (2017b). *Standards of medical care in diabetes-2017. Diabetes Care, 40,* S1–S135. doi:10.2337/dc17-S001

American Diabetes Association. (2018). Glycemic targets: Standards of medical care in diabetes-2018. *Diabetes Care, 41*, S55-S64. doi:10.2337/dc18-S006

American Diabetes Association. (2019). Diagnosis. Retrieved from https://www.diabetes.org/a1c/diagnosis

American Heart Association. (2018). Endurance exercise (aerobic). Retrieved from https://www.heart.org/en/healthy-living/fitness/fitness-basics/endurance-exercise-aerobic

Andrews, R., Cooper, A., Montgomery, A., Norcross, A., Peters, T., Sharp, D., . . .Dayan, C. (2011). Diet or diet plus physical activity versus usual care in patients with newly diagnosed type 2 diabetes: The early ACTID randomized controlled trial. *The Lancet, 378*, 129-139. doi:10.1016/S0140-6736(11)60442-X

Bahijri, S. M., Jambi, H. A., Rajaa M Al Raddadi, Ferns, G., & Tumoilehto, J. (2016). The prevalence of diabetes and pre-diabetes in the adult population of Jeddah, Saudi Arabia: A community-based survey. *PLOS ONE, 11*, e0152559. doi:10.1371/journal.pone.0152559

Balkau, B., Mhamdi, L., Oppert, J., Nolan, J., Golay, A., Porcellati, F., . . . on behalf of the EGIR-RISC Study Group. (2008). Physical activity and insulin sensitivity: The RISC study. *Diabetes, 57*, 2613-2618. 10.2337/db07-1605

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist, 28*, 117-148. doi:10.1207/s15326985ep2802_3

Bash, L. D., Selvin, E., Steffes, M., Coresh, J., & Astor, B. C. (2008). Poor glycemic control in diabetes and the risk of incident chronic kidney disease even in the absence of albuminuria and retinopathy atherosclerosis risk in communities study. *Archives of Internal Medicine, 168*, 2440–2447. doi:10.1001/archinte.168.22.2440

Bianco, A., Pomara, F., Thomas, E., Paoli, A., Battaglia, G., Petrucci, M., . . . Palma, A. (2013). Type 2 diabetes family histories, body composition and fasting glucose levels: A cross-section analysis in healthy sedentary male and female. *Iranian Journal of Public Health, 42*, 681- 690. Retrieved from http://ijph.tums.ac.ir/

Chawla, A., Chawla, R., & Jaggi, S. (2016). Microvasular and macrovascular complications in diabetes mellitus: Distinct or continuum? *Indian Journal of Endocrinology and Metabolism, 20*, 546-551. doi:10.4103/2230-8210.183480

Colberg, S. R., Sigal, R. J., Fernhall, B., Regensteiner, J. G., Blissmer, B. J., Rubin, R. R., . . . The American Diabetes Association. (2010). Exercise and type 2 diabetes: The American College of Sports Medicine and the American Diabetes Association: Joint position statement executive summary. *Diabetes Care, 33*, 2692-2696. doi:10.2337/dc10-1548

Coppell, K. J., Kataoka, M., Williams, S. M., Chisholm, A. W., Vorgers, S. M., & Mann, J. I. (2010). Nutritional intervention in patients with type 2 diabetes who are hyperglycaemic

despite optimised drug treatment: Lifestyle over and above drugs in diabetes (LOADD) study: Randomised controlled trial. *The BMJ, 341*, 237-237. doi:10.1136/bmj.c3337

Cradock, K. A., OLaighin, G., Finucane, F. M., Gainforth, H. L., Quinlan, L. R., & Martin Ginis K. A. (2017). Behavior change techniques targeting both diet and physical activity in type 2 diabetes: A systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity, 14,* 18. doi:1186/s12966-016-0436-0

Cugusi, L., PhD, Cadeddu, Christian, MD, PhD, Nocco, Silvio, MD, PhD, Orrù, F., MD, Bandino, S., MD, Deidda, M., MD, . . . Mercuro, G., MD. (2015). Effects of an aquatic-based exercise program to improve cardiometabolic profile, quality of life, and physical activity levels in men with type 2 diabetes mellitus. *Pm & r, 7*, 141-148. doi:10.1016/j.pmrj.2014.09.004

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. (2009). Statistical power analyses using GPower 3.1: Tests for correlation and regression analyses. *Behavior Research Methods, 41*(4), 1149-1160. doi:10.3758/BRM.41.4.1149

Fowler, M. J. (2008). Microvascular and macrovascular complications of diabetes. *Clinical Diabetes, 26,* 77-82. doi.10.2337/diaclin.26.2.77

Fowler, M. J. (2011). Microvascular and macrovascular complications of diabetes. *Clinical Diabetes*, 29, 116-122. doi:10.2337/diaclin.29.3.116

Galloway, R. D. (2003). Health promotion: Causes, beliefs and measurements. *Clinical Medicine & Research, 1*, 249-258. doi:10.3121/cmr.1.3.249

Ganz, M. L., Wintfeld, N., Li, Q., Alas, V., Langer, J., & Hammer, M. (2014). The association of body mass index with the risk of type 2 diabetes: A case-control study nested in an

electronic health records system in the United States. *Diabetology & Metabolic Syndrome, 6*, 50-50. doi:10.1186/1758-5996-6-50

Gliner, J.A., Morgan, G. A., & Leech, N.L. (2017). Research methods in applied settings. 3rd Ed. New York: Routledge.

Grove, S. K., Burns, N., & Gray, J. R. (2016). *The practice of nursing research: Appraisal, synthesis, and generation of evidence* (8th ed.). St. Louis, MO: Elsevier.

Grove, S. K., & Cipher, D. J. (2020). Statistics for Nursing Research: A workbook for evidence-based practice (3rd ed.). St. Louis, MO: Elsevier.

He, L., & Wondisford, F. (2015). Metformin action: Concentrations matter. *Cell Metabolism, 21*(2), 159-162. doi:10.1016/j.cmet.2015.01.003

International Diabetes Federation. (2013). *IDF diabetes atlas* (6th ed.). Retrieved from https://www.idf.org/e-library/epidemiology-research/diabetes-atlas/19-atlas-6th-edition.html

International Diabetes Federation. (2019). *IDF MENA members*. Retrieved from https://www.idf.org/our-network/regions-members/middle-east-and-north-africa/members/46-saudi-arabia.html

Jeon, B., Choi, H. J., Kang, J. S., Tak, M. S., & Park, E. S. (2016). Comparison of five systems of classification of diabetic foot ulcers and predictive factors for amputation. *International Wound Journal, 14,* 537–545. doi:10.1111/iwj.12642

Joseph, J. J., Echouffo-Tcheugui, J. B., Golden, S. H., Chen, H., Jenny, N. S., Carnethon, M. R., . . . Bertoni, A. G. (2016). Physical activity, sedentary behaviors and the incidence of type 2 diabetes mellitus: The multi-ethnic study of atherosclerosis (MESA). *BMJ Open Diabetes Research & Care, 4*, e000185. doi:10.1136/bmjdrc-2015-000185

Kader, S. M. Abd, E., Saiem-Aldahr, M. H., & Jiffri, O. H. A. (2016). Biochemical parameters response to treadmill exercise training in patients with chronic hepatitis C virus infection. *Journal of Pure and Applied Microbiology, 10*(2), 879. doi.10.1586/17434440.2015.1102049

Kermani, S. K., Khatony, A., Jalali, R., Rezaei, M., & Abdi, A. (2017). Accuracy and precision of measured blood sugar values by three glucometers compared to the standard technique. Journal of Clinical and Diagnostic Research: JCDR, 11, OC05-OC08. doi: 10.7860/JCDR/2017/23926.9613

Lari, H., Tahmasebi, R., & Noroozi, A. (2017). Effect of electronic education based on health promotion model on physical activity in diabetic patients. *Diabetes & Metabolic Syndrome*, 1-6. doi:10.1016/j.dsx.2017.08.013

Marwick, T. H., Hordern, M. D., Miller, T., Chyun, D. A., Bertoni, A. G., Blumenthal, R. S., . . . Council on Clinical Cardiology, American Heart Association Exercise, Cardiac Rehabilitation, and Prevention Committee. (2009). Exercise training for type 2 diabetes mellitus: Impact on cardiovascular risk: A scientific statement from the american heart association. *Circulation, 119*(25), 3244-3262. doi:10.1161/CIRCULATIONAHA.109.192521

Memish, Z. A., El Bcheraoui, C., Tuffaha, M., Robinson, M., Daoud, F., Jaber, S., . . . Al Rabeeah, A. A. (2014). Obesity and associated factors--kingdom of Saudi Arabia, 2013.*Preventing Chronic Disease, 11*, E174. doi:10.5888/ pcd11.140236.

Mohamed, B. A., Almajwal, A., M., Saeed, A. A., & Bani, I. A. (2013). Dietary practices among patients with type 2 diabetes in Riyadh, Saudi Arabia. *Journal of Food, Agriculture & Environment,11.* Retrieved from http://www.isfae.org

Mokabel, F. M., Aboulazm, S. F., Hassan, H. E., Al-Qahtani, M. F., Alrashedi, S. F., & Zainuddin, F. A. (2017). The efficacy of a diabetic educational program and predictors of compliance of patients with noninsulin-dependent (type 2) diabetes mellitus in Al-Khobar, Saudi Arabia. *Journal of Family and Community Medicine, 24*, 164-172. doi:10.4103/jfcm.JFCM_45_16

Morse, J. M. (1994). *Critical issues in qualitative research methods*. Thousand Oaks, CA: Sage

Motl, R. W., Dishman, R. K., Saunders, R., Dowda, M., Felton, G., & Pate, R. R. (2001). Measuring enjoyment of physical activity in adolescent girls. *American Journal of Preventive Medicine, 21*(2), 110-117. doi:10.1016/S0749-3797(01)00326-9

Myers, V. H., McVay, M. A., Brashear, M. M., Johannsen, N. M., Swift, D. L., Kramer, K., . . . Church, T. S. (2013). Exercise training and quality of life in individuals with type 2 diabetes: A randomized controlled trial. *Diabetes Care, 36*, 1884-1890. doi:10.2337/dc12-1153

National Eye Institute. (2015). *Facts about diabetic eye diseases*. Retrieved from https://nei.nih.gov/health/diabetic/retinopathy

Pender, N. J. (1982). *Health promotion in nursing practice*. NY: Appleton-Century-Crofts.

Pender, N. J. (1996). *Health promotion in nursing practice (3rd Ed.).* Stamford, CT: Appleton and Lange.

Pender, N. J., Murdaugh, C. L., & Parsons, M. A. (2001). *Health promotion in nursing practice (4th Ed.)*. Upper Saddle River, NJ: Prentice Hall.

Pender, N. J., Murdaugh, C. L., & Parsons, M. A. (2006). *Health promotion in nursing practice*. Upper Saddle River, NJ: Prentice Hall.

Peterson, S. J., & Bredow, T. S. (2013). *Middle range theories: Application to nursing research*

(3rd Ed.). PA: Lippincott Williams & Wilkins.

Pop-Busui, R., Boulton, A. J. M., Feldman, E. L., Bril, V., Freeman, R., Malik, R. A., . . . Ziegler, D. (2017). Diabetic neuropathy: A position statement by the American Diabetes Association. *Diabetes Care, 40*, 136-154. doi:10.2337/dc16-2042

Presset, B., Laurenczy, B., Malatesta, D., & Barral, J. (2018). Accuracy of a smartphone pedometer application according to different speeds and mobile phone locations in a laboratory context. *Journal of Exercise Science & Fitness, 16*(2), 43-48. doi:10.1016/j.jesf.2018.05.001

Samara, A., Nistrup, A., Al-Rammah, T. Y., & Aro, A. R. (2015). Lack of facilities rather than sociocultural factors as the primary barrier to physical activity among female Saudi university students. *International Journal of Women's Health, 7*, 279-286. doi:10.2147/IJWH.S80680

Sanghani, N. B., Parchwani, D. N., Palandurkar, K. M., Shah, A. M., & Dhanani, J. V. (2013). Impact of lifestyle modification on glycemic control in patients with type 2 diabetes mellitus. *Indian Journal of Endocrinology and Metabolism, 17*, 1030-1039. doi:10.4103/2230-8210.122618Shah, A. D., Langenberg, C., Rapsomaniki, E., Denaxas, S., Pujades-Rodriguez, M., Gale, C. P., . . . Hemingway, H. (2015). Type 2 diabetes and incidence of cardiovascular diseases: A cohort study in 1.9 million people. *The Lancet. Diabetes & Endocrinology, 3*, 105-113. doi:10.1016/S2213-8587(14)70219-0

Sekerci, Y. G. (2017). The impact of home visitation program on exercise behavior of women with type 2 diabetes. *International Journal of Medical Research and Health Sciences, 6,* 95-100. Retrieved from http://www.ijmrhs.com

Setford, S., Smith, A., McColl, D., Grady, M., Koria, K., & Cameron, H. (2015). Evaluation of the performance of the OneTouch select plus blood glucose test system against ISO 15197:2013. *Expert Review of Medical Devices, 12*, 771-781.

Sherif, S., & Sumpio, B. E. (2015). Economic development and diabetes prevalence in MENA countries: Egypt and Saudi Arabia comparison. *World Journal of Diabetes, 6*, 304-311. doi:10.4239/wjd.v6.i2.304

Singh, J., Rajbhandari, S. M., & Aslam, A. (2014). The impact of painful diabetic neuropathy on quality of life: An observational study. *Diabetes and Primary Care, 16*, 212-219. Retrieved from http://www.diabetesandprimarycare.co.uk/

Skyler, J. S., Bergenstal, R., Bonow, R. O., Buse, J., Deedwania, P., Gale, E. A. M., . . . American Heart Association. (2009). Intensive glycemic control and the prevention of cardiovascular events: Implications of the ACCORD, ADVANCE, and VA diabetes trials: A position statement of the American Diabetes Association and a scientific statement of the American College of Cardiology Foundation and the American Heart Association. *Journal of the American College of Cardiology, 53*, 298-304. doi:10.1016/j.jacc.2008.10.008

Song, R. (2016). Mechanism of metformin: A tale of two sites. *Diabetes Care, 39*, 187-189. doi:10.2337/dci15-0013

Sung, K., & Bae, S. (2012). Effects of a regular walking exercise program on behavioral and biochemical aspects in elderly people with type II diabetes. *Nursing & Health Sciences, 14*(4), 438-445. doi:10.1111/j.1442-2018.2012.00690.x

Tuttle, K. R., Bakris, G. L., Bilous, R. W., Chiang, J. L., de Boer, I. H., Goldstein-Fuchs, J., . . . The American Diabetes Association. (2014). Diabetic kidney disease: A report from an ADA consensus conference. *Diabetes Care, 37*, 2864-2883. doi:10.2337/dc14-1296

U.S. Department of Health and Human Services. (2018). *Physical activity guidelines for Americans (2nd ed.)*. Washington, DC: Author.

Vaishali, K., Kumar, K. V., Adhikari, P., & UnniKrishnan, B. (2012). Effects of yoga-based program on glycosylated hemoglobin level serum lipid profile in community dwelling elderly subjects with chronic type 2 diabetes mellitus-A randomized controlled trial. *Physical & Occupational Therapy in Geriatrics, 30*(1), 22-30. doi:10.3109/02703181.2012.656835

World Health Organization. (2015). *Physical inactivity and diabetes*. Retrieved from http://www.euro.who.int/en/health-topics/disease-prevention/nutrition/news/news/2015/11/physical-inactivity-and-diabetes

World Health Organization. (2018b). *Diabetes*. Retrieved from http://www.who.int/mediacentre/factsheets/fs312/en/

World Health Organization. (2018a). *Global health estimates summary tables: Projection of deaths by cause, age and sex. By world bank income group*. Retrieved from https://www.who.int/healthinfo/global_burden_disease/GHE_DthWBInc_Proj_2016-2060.xlsx?ua=1

World Health Organization. (2018d). *Obesity and overweight*. Retrieved from http://www.who.int/mediacentre/factsheets/fs311/en/

World Health Organization. (2018c). *Physical activity*. Retrieved from http://www.who.int/mediacentre/factsheets/fs385/en/

World Health Organization. (2019). *Global strategy on diet, physical activity and health.* Retrieved from https://www.who.int/dietphysicalactivity/physical_activity_intensity/en/

Appendix A

Data Collection Form

Subject ID number: _____

Pre-intervention Data Collection: Date _____ Time _____

Demographic Data -

Age (in years): _____

Number of years since DM diagnosis (in years): _____

Taking insulin? Yes / No

Taking oral diabetes medication? Yes / No

City of residence:

Primary Care Clinic:

Marital Status:

- Married
- Widow
- Divorced
- Single

How much education have you competed?

- Primary School
- High School
- University

Blood glucose level (fasting):

Height (in centimeters):

Weight (in kilograms):

Calculated BMI:

Post-intervention Data Collection: Date _____ Time _____

Blood glucose level (fasting):

Height (in centimeters):

Weight (in kilograms):

Calculated BMI:

Average number of steps during 8-week intervention:

Average number of exercise sessions per week during the 8-week intervention:

Appendix B

Demographic Information

Subject ID number: _____

1. What is your marital status?
   a) Single
   b) Married
   c) Divorced
   d) Widow

2. What is your age in years? _____

3. What is your highest educational status?
   a) Can read and write
   b) Finished elementary school
   c) Finished Middle school
   d) Finished High school
   e) Finished University

1. ماهي حالتك الاجتماعية؟
   - عزباء
   - متزوجه
   - مطلقه
   - ارمله
2. ما هو عمرك؟ _____
3. ماهي اعلي شهادة لديكي
   - أستطيع ان اقرا واكتب
   - ابتدائية
   - متوسطة
   - ثانويه
   - جامعه

Appendix C

Physical Activity Measure (StepsApp)

Link for Apple Device

https://apps.apple.com/om/app/stepsapp-

%D8%AE%D8%B7%D9%88%D8%A7%D8%AA%D9%8A/id1037595083?l=ar

Link for Android Device

https://play.google.com/store/apps/details?id=com.stepsappgmbh.stepsapp&hl=ar&gl=US

Appendix D

The Accu-Chek Perfoma Meter

The Accu-Chek Performa Meter is designed to monitor BG and can be used by healthcare professionals in clinical settings. It is a small battery-operated device that can be carried in patients' pockets. The front of the meter contains a display, right and left arrow buttons, and test strip slot. The power/set button and infrared window located on the top of the meter. The back side of the meter contains the battery door.

Appendix E

Post-intervention Efficacy Questions

1. Do you think the intervention was practical? Why?
2. How did you like the video?
3. Would you recommend this video to your family and friends? Why or why not?
4. In your opinion, what can be done to make it better?
5. What were the barriers to doing the activity?

1. هل تعتقد ان الفيديو كان عمليا؟ لماذا؟
2. كيف اعجبكم الفيديو؟
3. هل ستقومون بنصح الأصدقاء والاهل بمشاهده الفيديو؟ لماذا نعم او لماذا لا؟
4. في رأيكم مادا يمكننا ان نعمل لتكون التجربة أفضل؟
5. ماهي المعوقات التي واجهتكم؟

Appendix F

Motivational Phone Call (English)

[Part of the Intervention]

Hello, my name is Zainab Alyousef and I am the nurse that asked you to be in my study about exercise in Saudi women with diabetes. How are you?

I am calling to ask how your exercise sessions are going. Are you having any problems?

How do you like the online exercise sessions so far?

Are you having any pain or other problems in your muscles or joints?

Do you have any questions for me?

Keep up the good work!

Motivational Phone Call (Arabic)

مرحباً ، اسمي زينب اليوسف وأنا الممرضة التي طلبت منك أن تكون في دراستي حول التمرين لدى النساء السعوديات المصابات بداء السكري. كيف حالكم؟ انا اتصل لاسئلكم كيف تسير جلسات التمرين. هل لديك أي مشاكل؟

كيف هي جلسات التمرين عبر الانترنت حتى الان؟

هل تعاني من أي الم او مشاكل أخرى في عضلات او مفاصلك؟

هل لديك أي اسئله لي؟

ثابر علئ العمل الجيد!

Appendix G

Recruitment Script

Hello, my name is Zainab Alyousef. I'm a student in the doctoral program in the School of Nursing at the University of Texas at Arlington, USA. I am conducting a study to evaluate the effectiveness of a home-based, internet-delivered exercise intervention to decrease BG and weight, and to increase level of physical activity in Saudi women with DM and you are invited to participate in this study. Participation includes taking a survey about your demographic information and health status, which will take approximately 15 minutes. You will be also asked to attend a very short presentation about exercise and diabetes, which will take not more than 10 minutes. In addition, you will be asked to play an exercise YouTube video at home and exercise for at least 30 minutes a day for 5 days a week for 8 weeks. After 8 weeks, I will meet you back here at the health center to repeat your BG, weight, and physical activity. Would you be interested to know more about the study?

If No, then thank them for their time.

If Yes, then take them to a private room to explain the study and obtain informed consent.

Recruitment Screening Questionnaire

My name is Zainab Alyousef. I am a nurse works at Jubail General Hospital who is conducting a study about physical activity in Saudi women with Type 2 diabetes mellitus. If you are interested, I would like to know if you qualify for my study.

Please answer the questions below, and then return the paper to me.

1. Are you above 18 yrs. old?
    - If No, thank you for your time! You can stop the questionnaire here ☺
    - If yes, please proceed to next question
2. Do you have diabetes?
    - If No, thank you for your time! You can stop the questionnaire here ☺
    - If yes, please proceed to next question
3. Which type of diabetes you have?
    - Type 1 or
    - Type 2

    If you have type 1diabetes, we apologize that you cannot participate in the study. Thank you for your time! You can stop the questionnaire here ☺
4. Do you have any contraindication for exercise, such as a bad hip, knee, or foot problems?
    - If yes, thank you for your time! You can stop the questionnaire here ☺
    - If no, please proceed to next question
5. Do you have at least two smart devices at home, such as a phone, television, or tablet?
    - If no, thank you for your time! You can stop the questionnaire here
    - If yes, then please let me know that you are interested in participating☺

1. هل أنت فوق 18 سنه؟
   - إذا كان الجواب لا، شكرا لك على وقتك! يمكنك إيقاف الاستبيان هنا
   - إذا كانت الإجابة بنعم، يرجى الانتقال إلى السؤال التالي
2. هل لديك مرض السكري؟
   - إذا كان الجواب لا، شكرا لك على وقتك! يمكنك إيقاف الاستبيان هنا
   - إذا كانت الإجابة بنعم، يرجى الانتقال إلى السؤال التالي
3. اي نوع من السكري لديك، النوع 1 أو النوع 2؟
   - إذا كان لديك نوع 1 مرض السكري، نحن نعتذر عن إنك لا تستطيع المشاركة في الدراسة. شكرا لك على وقتك !يمكنك إيقاف الاستبيان هنا.
   - ادا كان لديكم النوع الثاني تفضلوا بإكمال الاستبيان
4. هل لديك اي موانع للتمرين مثل الم في الركبة او الحوض او مشاكل في القدم؟
   - إذا كان الجواب نعم، شكرا لك على وقتك! يمكنك إيقاف الاستبيان هنا
   - إذا كانت الإجابة لا، يرجى الانتقال إلى السؤال التالي
5. هل لديك جهازان ذكيان على الأقل في المنزل، مثل هاتف أو تلفزيون أو جهاز لوحي
   - إذا كان الجواب لا، شكرا لك على وقتك! يمكنك إيقاف الاستبيان هنا
   - إذا كانت الإجابة بنعم، أخبريني اذا كنت تودين المشاركة في البحث

Appendix H

Informed Consent Document

IRB Log Number:	N/A		**رقم البحث العلمي:**
Subject or Study Number:			**اسم المشارك:**
Medical Record Number:	N/A		**رقم السجل الطبي:**
Study Title:	**Diabetes and physical activity among Saudi women**		
	السكري والرياضة لدى النساء السعوديات		**عنوان البحث العلمي:**
Principal Investigator:	Zainab Mohammed Alyousef	زينب محمد اليوسف	**الباحث الرئيس:**
Affiliation:	Jubail General Hospital, University of Texas at Arlington	مستشفى الجبيل العام، جامعه تكساس بأرلينغتون	**مكان العمل :**
Telephone or Mobile No.:	+966545285500	٩٦٦٥٤٥٢٨٥٥٠٠+	**رقم الهاتف أو الجوال:**

Why this study is being done?

The purpose of this proposed study will be to evaluate the effectiveness of a home-based, internet-delivered exercise intervention to decrease fasting blood glucose and body mass index, and to increase level of physical activity in Saudi women with diabetes mellitus.

ما سبب القيام بهذا البحث العلمي؟

الغرض من هذه الدراسة المقترحة هو تقييم فعالية التدخلات المنزلية التي يتم تقديمها عبر الإنترنت لتقليل سكر دم الصائم وكتله الجسم، وزيادة مستوى النشاط البدني لدى النساء السعوديات المصابات بالسكري.

How many people will take part in this study? Sample size

1. 20 Saudi females diagnosed with Type 2 diabetes mellitus
2. 18 years old or older
3. No contraindication for exercise such as lack of feeling in feet, recent surgery, or recent muscle injury
4. No unstable retinopathy
5. No knee or ankle injury
6. No uncontrolled hypertension.
7. You must have two smart devices that can access the internet at home. One device has to be a smart phone and the other device could be a smart phone, computer, smart television, or an iPad.

كم عدد الأشخاص المفترض مشاركتهم في هذا البحث العلمي؟ حجم عينة البحث

1. 20 امراه سعودية مصابة بداء السكري من النوع الثاني ،
2. ١٨ سنه فما فوق
3. دون موانع لممارسة الرياضة مثل عدم الشعور بالقدمين، او خضعت لعمليه جراحيه حديثا، أو لديها أصابه حديثه في العضلات.
4. لا يوجد اعتلال شبكيه غير مستقر
5. لا يوجد إصابة في الركبة والكاحل
6. لا يوجد ضغط دم غير منتظم
7. يجب أن يكون لدى المشاركين جهازان ذكيان يمكنهما الوصول إلى الإنترنت في المنزل. يجب أن يكون أحد الأجهزة عبارة عن هاتف ذكي ويمكن أن يكون الجهاز الآخر عبارة عن هاتف ذكي أو كمبيوتر أو تلفزيون ذكي أو جهاز ايباد.

What are the objectives of the Study?

Improving diabetic patient health, fasting blood glucose, body mass index and level of physical activity

ما هي أهداف هذا البحث العلمي؟

تحسين صحة مريض السكر يتضمن سكري الصائم، كتله الجسم، ومستوى النشاط البدني

Study location: MOH facilities

Qatif primary care centers: Sanabis, Moneera, Mahdood,
Participants' home where you will exercise

موقع إجراء هذا البحث العلمي: منشآت وزارة الصحة

مركز صحي سنابس، المنيرة، المحدود
منزل المشارك

What is expected of me as participant during the study?

ما المطلوب مني كمشارك خلال هذا البحث العلمي؟

1. The duration of the study will be 10 weeks including data collection. Before starting the intervention, I will collect your demographic data, and you will be asked to attend one, short teaching session about exercise in the primary care center. Your fasting blood glucose, height, and weight will be measured twice, once before and once after the intervention.
2. You will be asked to play the YouTube video and exercise for at least 30 minutes per day, five days a week, for 8 weeks at home. You will be asked to keep your smart phone around your arm using the smartphone belt during the exercises. You will also be asked to download the steps application to record your daily steps.
3. After finishing the intervention, you will be asked to meet me in the clinic to re-measure your fasting blood glucose, height and weight, and answer 5 questions about the intervention. The pre- and post-intervention procedures may take up to 30 minutes of your time. The actual intervention will take a total of 20 hours of your time at home.

1. مدة الدراسة 10أسابيع تشمل فتره تجميع البيانات. قبل البدء سوف أقوم بتجميع بياناتك الديموغرافية وسأطلب منك ان تحضر محاضره قصيره عن الرياضة في المركز الصحي. سأقوم أيضا بقياس سكري الصوم والوزن والطول مرتين، مره قبل البدء في البرنامج الرياضي ومره بعد الانتهاء من البرنامج.
2. سيُطلب منك تشغيل فيديو YouTube وممارسة الرياضة لمدة 30 دقيقة على الأقل يوميًا خمسة أيام في الأسبوع في المنزل لمده 8 أسابيع. سيُطلب منك أيضًا إبقاء هواتفك الذكي حول الذراع باستخدام حزام الهاتف. أيضا سيطلب منك تحميل برنامج خطواتي في الهاتف الذكي الخاص بكم وأيضا تسجيل خطواتكم اليومية في الورق المرفق لكم
3. بعد الانتهاء من البرنامج الرياضي سيطلب منكم الحضور للمركز الصحي مجددا لأتمكن من قياس سكري الصوم والطول والوزن وأيضا سيطلب منكم الإجابة على 5 اسأله تخص البرنامج الرياضي .جميع إجراءات ما قبل بدء البرنامج وما بعده من المحتمل ان تأخذ ما يقارب 30دقيقه من وقتكم. كامل البرنامج سيستغرق ٢٠ ساعة من وقتكم في المنزل

Can I stop being in this study?

Participation is completely voluntary. You may stop participating at any time and you have the right not to answer any question that you do not want to answer

هل يمكنني إنهاء المشاركة في هذا البحث العلمي؟

المشاركة طوعيه محضة ويمكنك أن تنهيها في أي وقت تشاء. لك كامل الحق والاختيار في عدم الإجابة على أي سؤال لا تود الإجابة عنه

What are the benefits of this study?

Possible benefit of the study can be improving your health but it is not guaranteed

ما هي فوائد هذا البحث العلمي؟

الفائدة المحتملة من المشاركة في هذه الدراسة هو تحسين صحتكم ولكن لا يوجد ضمان بتحقيق الفائدة

وزارة الصحة
Ministry of Health

What are the risks of this study?

1. Efforts will be taken to protect your confidentiality and privacy. All identifiable information will be de-identified and the data will be kept in a password-protected computer.
2. There is no emotional harm expected to you if you participate in this study. The risk of muscle or joint injury is very minimal if you follow the exercise guidelines, starting slowly and increasing intensity and duration gradually.
3. To prevent bloodborne infectious diseases, a single-use, auto-disabling fingerstick device will be used for blood glucose. You may feel a little pain during the fingerstick. Your finger will be cleaned thoroughly to prevent any infection in your finger.

ما هي المخاطر المتوقعة من المشاركة في هذا البحث العلمي؟

1. سيتم بذل الجهود لحماية سريتكم وخصوصيكم. سيتم إلغاء تحديد جميع المعلومات المحددة للهوية وسيتم الاحتفاظ بالبيانات في جهاز كمبيوتر محمي بكلمة مرور.
2. لا يوجد ضرر جسدي أو عاطفي متوقع لكم عند المشاركة في هذه الدراسة. يكون خطر إصابة العضلات أو المفاصل ضئيلًا جدًا إذا اتبعت إرشادات التمرين، البدا ببطء وزيادة في شده ومدته التمرين تدريجيًا.
3. لمنع خطر الامراض المعدية سوف أقوم باستخدام ابر الأتوماتيكية ذات الاستخدام الواحد من الممكن ان تشعري بألم بسيط خلال الوخز. بعد الانتهاء من الوخز، اصبعك سوف ينظف جيدا لمنع أي انتقال للعدوة

What if I am injured because I took part in this study?

If you are injured as a result of being in this study, treatment will be provided by the primary care center at no cost to you.

ماذا سيحدث إذا أصابني ضرر جراء المشاركة هذا البحث العلمي؟

إذا حدث أن أصبت بضرر نتيجة مشاركتك في هذا البحث العلمي، سيقدم لك المركز الصحي العلاج دون أي تكلفة لك.

What are the costs of this study?

There are no costs to you if you take part in this study.

وما هي تكاليف المشاركة في هذا البحث العلمي؟

لا توجد تكاليف لك للمشاركة في هذه هذا البحث العلمي.

Will I be paid for taking part in this study?

There are no rewards to you if you take part in this study

هل هنالك اجر مقابل المشاركة في هذا البحث العلمي؟

لا توجد مكافآت لك إذا شاركت في هذه الدراسة

What are the alternatives?

There are no alternatives other than your usual health care.

ما هي البدائل؟

لا توجد بدائل

Will my information be kept private?

Your personal information will be kept private. It will be given out only if required by law. Your personal information will not be used in any reports.

هل سيتم الحفاظ علي معلوماتي بسرية؟

معلوماتك الشخصية سيتم الحفاظ عليها بسرية تامة. ولا تعطي إلا إذا اقتضى الأمر وذلك في حدود النظم والقوانين المطبقة بهذا الخصوص. معلوماتك الشخصية لن تستخدم في أي تقارير.

What are my rights if I take part in this study?

ما هي حقوقي إذا شاركت في هذا البحث العلمي؟

Taking part in this study is your choice. You may choose to take part or not to take part. If you decide to take part in the study, you can quit at any time. There will be no penalty to you for your decision. Your medical care will not change.

المشاركة في هذا البحث العلمي هي بمحض اختيارك. يمكنك أن تختار المشاركة أو لا. إذا قررت أن تشارك في هذا البحث العلمي، يمكنك التوقف في أي وقت تشاء. وإذا لم تشارك لن تكون هناك أي عقوبة لك، ولا تتأثر الرعاية الطبية المقدمة لك بسبب هذا القرار.

Who do I call if I have questions or problems?

If you have questions about the study, you can call Zainab Alyousef +966545285500. If you have any questions about "rights of human subjects," you may call the UTA Research office at +1817-272-3723 or send an email to regulatoryservices@uta.edu

بمن يمكنني الاتصال إذا كان لدي أسئلة أو مشاكل؟

إذا كانت لديك أسئلة عن هذا البحث العلمي، يمكنك الاتصال بالباحث الرئيس على هذا الرقم +966545285500. إذا كانت لديك أي تساؤلات حول "حقوق الاشخاص موضوع البحث، "يمكنك الاتصال برئيس لجنة أخلاقيات البحث العلمي (IRB) على الرقم. إذا كان لديك مكالمة طارئة اتصل ب .

CONSENT:
Subject:

I will receive a signed copy of this consent form.

إقرار بالموافقة:
المشارك:

أقر أنا بأن هذا البحث العلمي وإجراءاته قد تم شرحها لي. لقد سمح لي بأن اسأل كل سؤال لدي الآن. ويمكنني أن اسأل أي أسئلة إضافية في أي وقت لاحق. كما يمكنني إنهاء المشاركة في هذا البحث العلمي في أي وقت دون أن تتأثر الرعاية الصحية المقدمة لي.
سأحصل على نسخة موقعة من الإقرار بالموافقة.

Subject Signature: _____ **توقيع المشارك:** _____

Date: _____ **التاريخ:** _____

Time: _____ ☐ AM ☐ PM **الوقت:** _____ ☐ ص ☐ م

Person Obtaining Consent:

I have explained the nature and purpose of the study and the risks involved. I have answered and will answer questions to the best of my ability. I will give a signed copy of the consent form to the subject.

الشخص الحاصل على الإقرار بالموافقة:

أقر بأنني قد شرحت بصورة كاملة، طبيعة هذا البحث العلمي والغرض منه وما ينطوي عليه من مخاطر. ولقد أجبت على جميع الأسئلة بقدر الإمكان. سأعطي نسخة موقعة من الإقرار بالموافقة للمشارك المذكور أعلاه.

Signature of Person Obtaining Consent: _____ **توقيع الشخص الحاصل على الإقرار بالموافقة:** _____

Date: _____ **التاريخ:** _____

Time: _____ ☐ AM ☐ PM **الوقت:** _____ ☐ ص ☐ م

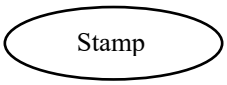
Principal Investigator:

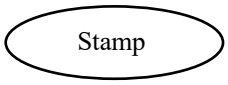
Signature of Principal Investigator: _____ **توقيع الباحث الرئيس:** _____

Date: _____ **التاريخ:** _____

Time: _____ ☐ AM ☐ PM **الوقت:** _____ ☐ ص ☐ م

الباحث الرئيس:


Stamp


Stamp

Appendix I

Intervention

Exercise Video Link:

Walk at Home by Leslie Sansone, (Nov 8, 2014). *Start walking at home American heart association 3-mile walk.* YouTube. https://www.youtube.com/watch?v=DYuw4f1c4xs

Teaching Session

English Version

Content from

American Diabetes Association. (2020). Blood Sugar and Exercise. Retrieved from https://www.diabetes.org/fitness/get-and-stay-fit/getting-started-safely/blood-glucose-and-exercise
American Diabetes Association. (2020). *Injury-Free Exercise-11 Quick Safety Tips.* Retrieved from https://www.diabetes.org/fitness/get-and-stay-fit/getting-started-safely/injury-free-exercise-11-quick-safety-tips

Mayo Clinic. (2018*). Diabetes and Exercise: When to Monitor your Blood Sugar.* Retrieved from https://www.mayoclinic.org/diseases-conditions/diabetes/in-depth/diabetes-and-exercise/art-20045697

1. **Impact of exercise on diabetes:**

Exercise can lower your blood sugar in different ways:

- Insulin sensitivity is increased so your muscle cells are able to use any available insulin to take up glucose during and after activity
- When your muscles contract during activity, your cells are able to take up glucose and use it for energy whether insulin is available or not
- When you commit to exercise on a regular basis for at least 150 minutes per week, exercise can lower your $HbA1_C$

2. **Exercising safely with diabetes**

a. **Blood sugar**

Before starting an exercise session, test your blood sugar. If it is:

- **Lower than 100 mg/dL (5.6 mmol/L).** Your blood sugar may be too low to exercise safely. Eat a small snack containing 15 to 30 grams of carbohydrates, such as fruit juice, fruit, or crackers before you begin your workout.
- **100 to 249 mg/dL (5.6 to 13.9 mmol/L).** You're good to go. For most people, this is a safe pre-exercise blood sugar range.
- **250 mg/dL (13.9 mmol/L) or higher.** This is a caution zone — your blood sugar may be too high to exercise safely. Before exercising, test your urine for ketones — substances made when your body breaks down fat for energy. The presence of ketones indicates that your body doesn't have enough insulin to control your blood sugar.

If you exercise when you have a high level of ketones, you risk ketoacidosis — a serious complication of diabetes that needs immediate treatment. Instead of exercising immediately, take measures to correct the high blood sugar levels and wait to exercise until your ketone test indicates an absence of ketones in your urine.

b. Warm up

If you have never been active or haven't been active for a while, start slowly. Warm up for 5 minutes before starting to exercise and cool down for 5 minutes after.

Your warm up and cool down should be a lower intensity than the rest of your time exercising. This helps get your blood flowing and warms up your joints.

c. How to Exercise

- Avoid doing activity in extremely hot or cold temperatures. Choose indoor options when the weather is extreme.
- Drink plenty of water before, during, and after activity to stay hydrated.

- If you feel a low sugar coming on, be ready to test for it and treat it. Always carry a source of carbohydrate with you so you'll be ready to treat low blood sugar.
- Wear a medical identification bracelet, necklace, or a medical ID tag that identifies you as someone with diabetes in case of an emergency.
- Activities should be energizing but not overly difficult.

  Use the "talk test" to make sure you are not pushing yourself too hard. If you become short of breath and you can't talk, then slow down. This is most important when you are just starting to increase the activity in your routine. As you become fit, you'll be able to exercise at a higher intensity and chat with others while you do it.
- Take care of your feet by wearing shoes and clean socks that fit you well.

  You should also check inside your shoes before wearing them. Shoes with silica gel or air mid-soles are a good choice for weight-bearing activities like walking because they are built to reduce stress on your feet and joints. Socks that are made of a material that reduces friction and pulls moisture away from your skin can also help protect your feet. Some examples are CoolMax, polypropylene, or acrylic (stay away from cotton).
- Carefully inspect your feet before and after activity for blisters, redness, or other signs of irritation. Talk to your doctor if you have a foot injury or a non-healing blister, cut, or sore.
- Stop doing an activity if you feel any pain, shortness of breath, or light-headedness. Talk to your doctor about any unusual symptoms that you experience.

Teaching Session

Arabic Version

فوائد ممارسه الرياضة لمرضى السكري:

- يمكن ان تخفض التمارين الرياضية مستوي السكر في الدم بطرق مختلفة :
  - يتم زيادة حساسية الانسولين ويعني ان خلايا العضلات الخاصة بك قادره على استخدام الانسولين المتوفر لتناول الجلوكوز اثناء وبعد النشاط
  - خلال انقباض العضلات اثناء النشاط، الخلايا الخاصة بك قادره على تناول الجلوكوز واستخدامه للطاقة سواء يوجد انسولين ام لا
  - عند الالتزام بممارسه التمارين الرياضية على أساس منتظم لمده 150 دقيقه على الأقل في الأسبوع، يمكن ان تخفض التمارين الرياضية نسبهhba1c ك

ممارسه الرياضة بأمان مع مرض السكري

قبل البدء في جلسة تمرين، اختبر سكر الدم. إذا كان

اقل من 100ملغم/دل (5.6 ملليمول/لتر)

قد يكون السكر في الدم منخفضا جدا لممارسه الرياضة بأمان. تناول وجبه خفيفة صغيره تحتوي علي 15 إلى 30 جرام من الكربوهيدرات، مثل عصير الفواكه أو الفواكه أو المفرقعات قبل ان تبدا التمرين .

100إلى 249 ملغم/دل (5.6 إلى 13.9 ملليمول/لتر)

. أنت جيد للممارسة الرياضة بآمان. بالنسبة لمعظم الناس .

250ملغم/دل (13.9 ملليمول/لتر) أو اعلي.

هذا هو منطقه الحذر

قد يكون السكر في الدم عالية جدا لممارسه الرياضة بأمان.

قبل ممارسه الرياضة، اختبري البول لمعرفه ادا كان البول يحتوي على المواد التي يتم صنعها عندما يكسر الجسم الدهون للحصول على الطاقة تعدى الكيتون

. وجود كيتون يشير إلى ان جسمك لا يملك ما يكفي من الانسولين للسيطرة على السكر في الدم .إذا كنت تمارس التمارين الرياضية عندما يكون لديك مستوي عال من الكيتون، فأنك تخاطر بالإصابة بحموضه الدم وهي مضاعفات خطيره لداء السكري تحتاج إلى علاج فوري. بدلا من ممارسه على الفور، اتخاذ تدابير لتصحيح مستويات السكر العالية في الدم والانتظار حتى اختبار كيتون الخاص بك يشير إلى عدم وجود كيتون في البول.

1. إذا لم تكن نشطا أبدا أو لم تكن نشطا لفتره من الوقت، فأبدا ببطء.
2. الإحماء لمده 5 دقائق قبل البدء في ممارسه وتهدئه لمده 5 دقائق بعد.
   الإحماء الخاص بك أو تهدئه يجب ان يكون اقل كثافة من بقية وقتك ممارسه. وهذا يساعد علي تدفق الدم ويدفئ المفاصل.
3. تجنب القيام بالنشاط في درجات حرارة ساخنه أو بارده للغاية. اختيار الخيارات الداخلية عندما يكون الطقس المدقع .
4. اشرب الكثير من الماء قبل واثناء وبعد النشاط لتبقي رطبه
5. إذا كنت تشعر منخفضه القادمة علي، تكون علي استعداد لاختبار لذلك وعلاجه. تحمل دائما مصدرا من الكربوهيدرات معك لذلك عليك ان تكون على استعداد لعلاج انخفاض نسبه السكر في الدم.

6. ارتداء سوار التعريف الطبي، قلادة، أو علامة الهوية الطبية التي تحدد لك كشخص مع مرض السكري في حاله الطوارئ، وتحمل الهاتف الخليوي معك في حال كنت في حاجه للاتصال شخص للحصول على المساعدة.
7. وينبغي ان تكون الأنشطة منشطه ولكن ليست صعبه للغاية.

استخدام "اختبار الحديث" للتأكد من أنك لا تدفع نفسك من الصعب جدا. إذا كنت اقل من التنفس وكانت لا تستطيع التحدث، ثم تبطئ. هذا هو الأكثر اهميه عندما كنت بدأت للتو لزيادة النشاط في روتينك. كما يمكنك ان تصبح مناسبا، عليك ان تكون قادرا على ممارسه الرياضة في كثافة اعلي والدردشة مع الآخرين اثناء القيام بذلك.

8. اعتني بقدميك من خلال ارتداء الأحذية والجوارب النظيفة التي تناسبك جيدا.

يجب عليك أيضا التحقق داخل حذائك قبل ارتدائها. الأحذية مع هلام السيليكا أو الهواء منتصف باطن هي خيار جيد لأنشطه تحمل الوزن مثل المشي لأنها بنيت للحد من الإجهاد علي قدميك والمفاصل. الجوارب المصنوعة من المواد التي تقلل من الاحتكاك وتسحب الرطوبة بعيدا عن بشرتك يمكن ان تساعد أيضا في حماية قدميك. بعض الأمثلة هي CoolMax ، البولي بروبيلين ، أو الأكريليك (الابتعاد عن القطن(

9. افحص قدميك بعناية قبل وبعد النشاط لظهور بثور أو احمرار أو علامات تهيج أخرى. التحدث مع طبيبك إذا كان لديك أصابه في القدم أو نفطه غير الشفاء، وقطع، أو قرحه
10. توقف عن القيام بنشاط إذا كنت تشعر بأي الم أو ضيق في التنفس أو صداع في الراس. تحدث إلى طبيبك حول اي اعراض غير عادية تواجهها .

Appendix J

Daily Steps Record

Below is a diary to record your daily steps for eight weeks. You will need to check your daily steps each day through steps application and record them in the column (total daily steps). Before starting the intervention please record your total daily steps for three days:

First day _____steps

Second day _____steps

Third day_____steps

يوجد أدناه مفكرة لتسجيل خطواتك اليومية. ستحتاج إلى التحقق من خطواتك اليومية كل يوم من خلال تطبيق الخطوات وتسجيلها في العمود (اجمالي الخطوات اليومية).

قبل البدء في البرنامج الرجاء تسجيل خطواتكم لمده ثلاث أيام:

اليوم الأول: _____ خطوه،

اليوم الثاني: _____ خطوه، اليوم الثالث: _____ خطوه

الأسبوع الاول1 Week	
الأيام/ Days	مجموع الخطوات اليومية total daily steps
ألاحد	
الاثنين	
الثلاثاء	
الاربعاء	
الخميس	
الجمعة	
السبت	

الأسبوع الثالث Weeks 3	
الأيام/ Days	مجموع الخطوات اليومية total daily steps
ألاحد	
الاثنين	
الثلاثاء	
الاربعاء	
الخميس	
الجمعة	
السبت	

الأسبوع الثاني Weeks 2	
الأيام/ Days	مجموع الخطوات اليومية total daily steps
ألاحد	
الاثنين	
الثلاثاء	
الاربعاء	
الخميس	
الجمعة	
السبت	

الأسبوع الرابع Week 4	
الأيام/ Days	مجموع الخطوات اليومية total daily steps
ألاحد	
الاثنين	
الثلاثاء	
الاربعاء	
الخميس	
الجمعة	
السبت	

الأسبوع الخامس Week 5	
الأيام/ Days	مجموع الخطوات اليومية total daily steps
ألاحد	
الاثنين	
الثلاثاء	
الاربعاء	
الخميس	
الجمعة	
السبت	

الأسبوع السادس Week 6	
الأيام/ Days	مجموع الخطوات اليومية total daily steps
ألاحد	
الاثنين	
الثلاثاء	
الاربعاء	
الخميس	
الجمعة	
السبت	

الأسبوع السابع Week 7	
الأيام/ Days	مجموع الخطوات اليومية total daily steps
ألاحد	
الاثنين	
الثلاثاء	
الاربعاء	
الخميس	
الجمعة	
السبت	

الأسبوع الثامن Week 8	
الأيام/ Days	مجموع الخطوات اليومية total daily steps
ألاحد	
الاثنين	
الثلاثاء	
الاربعاء	
الخميس	
الجمعة	
السبت	