Differences in exercise behaviors by diabetes status: Implications for Americans with type 1 diabetes

by

Cassandra Maria Beattie

B.S., Kansas State University, 2018

A THESIS

submitted in partial fulfillment of the requirements for the degree

MASTER OF SCIENCE

Department of Kinesiology
College of Health and Human Sciences

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2019

Approved by:

Major Professor
Katie Heinrich

Copyright

Abstract

Background: In the United States, 9.4% of adults have type one or type two diabetes (T1D, T2D). Although Federal physical activity (PA) guidelines including aerobic and strength training exercises are recommended for T2D; guidelines are not provided for T1Ds. A better understanding of differences in PA behaviors between T1D and T2D populations is needed, along with comparisons to non-diabetic (ND) Americans. As a health behavior, PA is influenced by factors such as knowledge and beliefs, degree of self-regulation skills and abilities, and the degree of social facilitation, as captured in the Integrated Theory of Health Behavior Change (ITHBC). **Purpose:** This study compared PA behaviors of adults with T1D, T2D, and NDs as well as examined how their PA behaviors fit into the ITHBC framework (knowledge and beliefs, social facilitation, self-regulation skill and ability, engagement of self-management behavior, and health status). T1D were hypothesized to achieve more activity in average moderate and vigorous aerobic minutes per week and average days per week of strength training than T2D. **Methods:** Male (n=68) and female (n=267) participants ages 18-64 were recruited via social media (e.g. Facebook, Instagram) and University newsletter (K-State Today) and indicated consent prior to participation in an online survey. Data were collected for demographics, anthropometrics, diabetes status, and PA behaviors. One-way ANOVAs, with Games-Howell post hoc tests were used to determine differences in aerobic activity and strength training between T1D, T2D, and ND participants. **Results:** Participants included 48 T1Ds, 24 T2Ds, and 240 NDs. Statistically significant differences existed for moderate aerobic PA between groups, $f(2, 304) = 3.9$, $p = 0.021$, where T2D reported significantly fewer weekly minutes (109.2 ± 88.8) than ND (215.7 ± 186.5; $p = 0.021$); T1D's weekly minutes (179.0 ± 171.7) were not significantly different. No significant vigorous PA differences were found between groups ($p =$

0.242; T1D = 66.3 ± 80; T2D = 41.7 ± 60.5; ND = 73.8 ± 94.8 min/week). Strength training days/week differed between groups, $f(2, 314) = 3.6$, $p = 0.028$ with T1D (1.8 ± 2.0) reporting significantly more than T2D (0.7 ± 1.0; $p = 0.024$); ND's days/week (1.5 ± 1.7) were not significantly different. Some diabetic participants felt moderately satisfied (34.2%) with their current exercise knowledge, while 62.3% wanted to gain more exercise knowledge. About 50% of the sample participated in active goal setting for their health and had current health goals, while 79.6% of the sample reported participating in exercise preparation behaviors and 85.6% participated in post-exercise care behaviors. The main forms of physical activity and exercise were walking and strength training. **Conclusion:** The hypothesis was partially supported in that participants with T1D reported significantly more strength training days/week than those with T2D, approaching the recommended 2 days/week. Of note, participants with T1D reported mean moderate PA greater than the recommended 150 min/week. A third of diabetic participants were satisfied with their current exercise knowledge while another 2/3 of diabetic participants wanted to gain more exercise knowledge. Current literature has reported that doctors who specialize in diabetes do not believe they have enough knowledge about the illness in relation to exercise to provide recommendations. Future studies should look deeper into PA knowledge not only of T1D and T2D, but of diabetic populations and their health care team members. Research should look into how individually and together this influences activity levels of diabetic populations.

Table of Contents

List of Figures

List of Tables

Acknowledgements

Lead Thesis Committee Member, Advisor, and Mentor:

Dr. Katie Heinrich (Associate Professor in Kinesiology)

Additional Thesis Committee Members and Mentors:

Dr. Steven Copp (Assistant Professor in Kinesiology)

Dr. Gina Besenyi (Assistant Professor in Kinesiology)

Off-Campus Partners:

Dr. Yuri Feito (Associate Professor in Exercise Science and Sport Management)

Supervisory Department: Kinesiology

Supervisory College: Human Ecology

Grant Funding: Office of Undergraduate Research and Creative Inquiry (OURCI)

Chapter 1 - Literature Review

Defining Diabetes

Diabetes is a complex chronic illness characterized by the body's inability to produce or use insulin (American Diabetes Association; ADA, 2018). The hormone insulin is produced by the pancreas by beta cells that regulate the amount of glucose in the blood. Cells in the body cannot utilize glucose without insulin, therefore insulin is essential to the production of energy through the glycolytic energy pathways (ADA, 2018). Many Americans are most commonly affected by type 1 (T1D) and type 2 diabetes (T2D), therefore the differing characteristics of these diseases should be identified.

T1D is also known as 'insulin-dependent' or 'juvenile-diabetes' and is usually diagnosed in children, teens and young adults, but it can develop at any age (Centers for Disease Control and Prevention; CDC, 2018b). T1D most commonly develops before the age of 40, but in the US the average age at diagnosis is around 14 years (Norman, 2019). T1D is a chronic autoimmune disorder that precipitates in genetically susceptible individuals by environmental factors (Van Belle, Coppieters, & Von Herrath, 2011). In people with T1D the body's own immune system attacks the beta-cells in the islets of the Langerhans of the pancreas, destroying and/or damaging them sufficiently enough to reduce and eliminate insulin production (Van Belle et al., 2011). People with T1D are advised to continuously monitor their A1C levels and blood glucose levels to try to stay within healthy ranges (Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group, 2009). In a 6-month extension to a randomized clinical trial, most adults 25 years or age or older used continuous glucose monitoring on a daily or nearly daily basis (Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group, 2009). These individuals had sustained benefits of improved blood glucose control that were

reflected in their A1C levels and the number of times the blood glucose was in target range (Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group, 2009). T2D, also known as 'non-insulin-dependent' diabetes, is usually diagnosed in people over the age of 45 and is a condition that causes muscle, liver, and fat cells to become resistant to effects of insulin and unable to effectively utilize it, causing higher than normal blood glucose to develop as the body cannot break down or use glucose (ADA, 2018). Blood glucose monitoring has been recommended for T2D, but more commonly for T1D in order to maintain good health (Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group, 2009).

Prevalence of Diabetes

In 2006, the World Health Organization (WHO) declared diabetes an epidemic, and rates have continued to rise since that time (Smyth & Heron, 2006; Minges, Whittemore, & Grey, 2013). Every year, 1.5 million new diagnoses of diabetes are made (ADA, 2019). In 2015, over 30 million Americans were diagnosed with a diabetic condition (CDC, 2017a). Additionally, 84.1 million Americans are prediabetic, a condition that often progresses to T2D within approximately five years (CDC, 2018c). Ninety to 95% percent of the American population with diabetes have T2D, the remaining 5% have T1D, making it considerably less common than T2D (CDC, 2018c; CDC, 2018c).

Obesity & Diabetes

There continues to be increases in diabetes and a common comorbidity, obesity, among adults of both sexes, all ages, all races, all educational levels, and all smoking levels in the United States (US) (Bhupathiraju & Hu, 2016). Overweight and obesity are becoming highly prevalent among youth and adults with T1D, with global rates increasing up to 3-4% a year (Polsky & Ellis, 2015; Minges et al., 2013). Youth with T1D have been identified as overweight

or obese with the same or greater prevalence than their non-diabetic (ND) peers, with rates reaching 25–35% among T1D children (Polsky & Ellis, 2015). Obesity-related comorbidities predominate among individuals with T2D are increasingly being found in individuals with T1D (Polsky & Ellis, 2015), including developing symptoms of both T1D and T2D, or double diabetes. Double diabetes has been characterized by the presence of hyperglycemia in youth and young adults that have a combination of common markers for both T1D and T2D. Although double diabetes is a recent discovery, it appears to already be increasing in prevalence (Pozzilli & Buzzetti, 2007).

Of additional concern, it is common for people with diabetes and obesity to suffer from other chronic health conditions (Piette & Kerr, 2006). For example, obesity is associated with psychological conditions such as low self-esteem and clinical depression (Smyth & Heron, 2006). The Medical Expenditure Panel Survey reported that most adults with diabetes have at least one comorbidity while as many as 40% have at least three comorbidities (Piette & Kerr, 2006). Having obesity in addition to diabetes only increases these comorbidity rates (Piette & Kerr, 2006). Obesity-related health conditions include increased risks of cardiovascular disease, gastrointestinal diseases and arthritis, cancer, hypertension, dyslipemia, Nonalcoholic Fatty Liver Disease, obstructive sleep apnea, advanced heart failure and dementia and diabetes (Smyth & Heron, 2006).

These illnesses and comorbidities associated with diabetes can incur major costs for medical care (Piette & Kerr, 2006). Not only is the cost to manage diabetes a lot for the individual, but it is even more costly to the US healthcare systems and ultimately tax-payers (Smyth & Heron, 2006). The total costs of diagnosed diabetes expenses in the US in 2017 were

$327 billion (ADA, 2019). The direct medical costs were $237 billion, and reduced productivity cost $90 billion (ADA, 2019).

Fortunately, inexpensive treatment options exist for diabetes and obesity, such as physical activity and exercise. Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure (USDHHS, 2018). Exercise is defined as a form of physical activity that is planned, structured, repetitive and aimed to either improve or maintain physical fitness, performance, and health (USDHHS, 2018). For the purposes of this study, we will focus on physical activity and exercise.

Physical Activity Recommendations

The 2018 Physical Activity Guidelines recommend children and adolescents with T1D engage in 60 minutes per day of moderate to vigorous intensity aerobic physical activity (MVPA) with muscle and bone strengthening activities at least 3 days per week (USDHHS, 2018b). Aerobic activity is defined as forms of activity that engage the body's large muscle groups in a sustained rhythmic manner to either maintain or improve one's cardiorespiratory fitness (USDHHS, 2018). These activities include walking, biking, running, dancing, and bicycling. Examples of moderate intensity aerobic activities include brisk walking, biking, or doubles tennis (USDHHS, 2018). Vigorous intensity activities can include running, swimming laps, and participating in vigorous step aerobics classes, among others (USDHHS, 2018). Muscle strengthening activities either maintain or improve muscular strength, muscular endurance, and muscular power and include activities such as: lifting weights, using resistance bands, or body weight exercises (e.g., push-ups, lunges) (USDHHS, 2018). Bone strengthening activities are movements that create impact and muscle loading forces on the bone in order to stimulate bone remodeling and an increase in bone mineral density (USDHHS, 2018). This helps individuals

from breaking or fracturing bones. Bone strengthening activities can include jumping, hopping, skipping, and muscle strengthening activities (free weights) (USDHHS, 2018). For adults, it is recommended individuals with T1D engage in at least 150 minutes of moderate to vigorous physical activity per week over the course of 3 days, with no more than 2 consecutive days without activity (USDHHS, 2018b).

The American Diabetes Association (ADA) recently published physical activity recommendations for persons with T1D and T2D in the Diabetes Care Journal similar to the 2018 Physical Activity Guidelines for Americans but including specific guidance for diabetes-related complications. (ADA, 2018). The ADA also includes recommendations for lifestyle management that revolve around insulin care, nutrition, and physical activity. According to the ADA, physical activity and exercise have been shown to improve blood glucose control, something that many diabetic individuals struggle with (ADA, 2018). Exercise also helps reduce cardiovascular risk factors, contribute to weight loss, and improve the well-being (e.g., quality of life) of those who suffer from diabetes (ADA, 2018). Physical activity recommendations from the ADA vary depending on age, disease type and physical activity ability (ADA, 2018).

While increased physical activity may improve diabetes conditions and management, many people with T1D and T2D fail to meet the 2018 Physical Activity Guidelines, which is related to increasing rates of obesity; thus, placing them at higher-risk for other chronic diseases (USDHHS, 2018). In a large epidemiological study of adults with T1D (n = 1,274), T2D (n = 27, 257), and ND (n = 353.928) who reported their health as good-to-excellent, similar percentages of T1D (63.1%) and T2D (62.1%) reported meeting aerobic physical activity guidelines. However, the percentage was 90.9% meeting aerobic physical activity guidelines among ND

participants (Zhao, Ford, Li & Mokdad, 2008. However, a deeper theoretical understanding of how physical activity behaviors differ by diabetes status merits further investigation.

Physical Activity Behaviors

In order to examine whether US adults with diabetes met both the national and ADA recommendations for physical activity and to examine the physical activity participation trends over time data from the Behavioral Risk Factor Surveillance System (BRFSS) were analyzed (Zhao et al., 2008). This large study used BRFSS data among more than 23,000 US adults (Zhao et al., 2008). Approximately 1,697 had T2D and 55 had T1D, although their data were collapsed for analysis. Those with any type of diabetes were less likely to be physically active. Only about 63% were physically active the month prior to the survey, but the majority of the 63% did not do enough activity to meet federal or ADA recommendations (Zhao et al., 2008). Since T1D sample sizes are typically too small to differentiate between diabetes type, their data are often collapsed into a single group with diabetes despite the considerable difference in the disease subtypes. Thus, the available data differentiating physical activity behaviors of T1D from both T2D and ND is limited. Therefore, further information should be gathered in order to differentiate the activity levels between T1D and T2Ds in order to learn more about T1D activity and their differences as compared to T2D and NDs.

Diagnosis for T1D peaks between the ages of 10-14, stabilizes between ages 15-29, and yet occurs after age 40 for about 25% of cases (Maahs, West, Lawrence & Mayer-Davis, 2010). Prevalence of T2D diagnosis increases with age, the peak diagnoses are among women between the ages of 60-74 (Gadsby, 2002). Therefore, age of participants is an important consideration when comparing physical activity data between those with T1D and T2D.

Rates of US adults meeting physical activity guidelines decreases with age (Whitfield et al., 2019). Rates are 33.8% for ages 18-24, 30.6% for ages 25-34, 27.5% for ages 35-44 and 20.7% for ages 45-64 (Whitfield et al., 2019). Thus, age is an important factor to consider when examining physical activity rates between adults with T1D and T2D as those with T1D tend to be younger and therefore are more likely to report higher physical activity levels (Whitfield et al., 2019).

Integrated Theory of Behavior Health Change

As a health behavior, physical activity is influenced by factors such as knowledge and beliefs, degree of self-regulation skills and abilities, and the degree of social facilitation, as captured in the Integrated Theory of Health Behavior Change (ITHBC) (Ryan, 2009). The ITHBC is designed to understand and facilitate health behavior change pertinent to the management of chronic illnesses and health promotion. The theory assumes that individuals will be more likely to participate in recommended health behaviors if they are 1) are supplied with information about and adopt health beliefs consistent with behavior; 2) experience social facilitation resulting in a positive influence that promotes engagement in preventive health behaviors; and 3) develop self-regulation skills to change their current health behaviors. According to this theory, enhancing one's knowledge and beliefs, degree of self-regulation skills and abilities, and the degree of social facilitation in regard to specific health behaviors can result in positive behavior change. This behavior change occurs from the increased understanding of a specific condition or behavior, increased behavior-specific self-efficacy (confidence in one's ability to engage in a change), increased outcome expectancy (the belief that engagement in a behavior results in desired outcome), and increased goal congruence (resolution of confusion occurring from competing demands associated with one’s health goals) (Ryan, 2009).

Knowledge is characterized as condition-specific factual information; beliefs are characterized as personal opinions about specific health conditions and behaviors (Ryan, 2009). Social facilitation is when an individual is influenced or persuaded by a slightly more dominant or experienced individual (Ryan, 2009). Social facilitation may come from healthcare providers, television and radio, family and neighbors, coworkers, or printed or electronic communications, and their social support facilitates engagement in a health behavior (Ryan, 2009). Self-regulation includes goal setting, self-monitoring, and reflective thinking. Enhancement of self-regulation skills through positive social facilitation results in enhancements in engagement in self-management behaviors which can positively affect health status (Ryan, 2009). Our focus will be on how these components of the ITHBC play a role in physical activity behaviors, with an examination of differences by diabetes status.

Chapter 2 - Introduction

According to the ADA, diabetes is a chronic illness that is characterized by the inability of the pancreas to produce or use insulin, a pancreatic hormone that reduces blood glucose levels (ADA, 2018). The two main diabetes classifications are T1D and T2D. T1D is classified by its autoimmune destruction of insulin-producing beta cells that leads to a complete insulin deficiency, commonly diagnosed as a young adolescent or young adult (ADA, 2018). T2D is classified by its progressive loss of beta cell insulin secretion commonly due to insulin resistance, commonly diagnosed in middle-aged adults. The percentage of the population diagnosed with diabetes continues to rise, with one study projecting as many as one in three US adults could have a diabetes diagnosis by 2050 if the current trend persists (ADA, 2013). The US has the greatest prevalence of diabetes among developed nations, approximately 11% of its population between 20-79 years of age (Atlas, 2015). The developed nations consists of 37 nations (e.g. countries of the European Union plus Canada, Australia, New Zealand, Singapore, South Korea, Israel, Andorra, Norway, Switzerland, and the US) with approximately 46 million cases of diabetes (Atlas, 2015); the US makes up two thirds of the cases of diabetes out of all 37 developed nations (Atlas, 2015). According to the WHO, reported increases in diabetes prevalence are mainly due to increases in cases of T2Ds, although cases of obesity and T1Ds are also increasing (Smyth & Heron, 2006).

When adjusted for inflation rates, the economic costs of diabetes in the US increased by 26% over the last 5 years due to the increasing prevalence of T1D and T2D and the increased cost per person diagnosed with diabetes (ADA, 2013). Both T1D and T2D force a hefty financial burden on the U.S. via direct medical costs and indirect costs of lost productivity, cost of premature mortality, and indefinite costs of a reduced quality of life due to illness (ADA, 2013).

When adjusted for age and sex, the annual medical expenditures for diabetics are 2.3 times higher than their ND counterparts (ADA, 2013). Most of these diabetes-associated costs result from comorbidities and the management of diabetes-related complications (Smyth & Heron, 2006). Due to the low compliance of healthy eating and physical activity participation by the increasing number of T1D and T2D adults in the US, pharmaceutical companies have attempted to remedy the problem of inactivity and nutrition by creating drugs to be prescribed such as metformin to help aid diabetes symptoms (Smyth & Heron, 2006). Pharmaceuticals are often used try to solve the issue of diabetes and hyperglycemia rather than through inexpensive methods such as physical activity and exercise (Smyth & Heron, 2006).

The 2018 Physical Activity Guidelines Advisory Committee Scientific Report, The American Diabetes Association Diabetes Care Journal, and the American College of Sports Medicine were unable to draw a conclusion on recommended types of physical activity and exercise for T1Ds as studies lacked information about optimal frequency, duration, intensity, and type. No evidence was provided in the report for T1D populations and physical activity or exercise, the report does mention T1D but in the context they were included in the same large cohort study as those with T2D (USDHHS, 2018). However, guidelines do exist for T2D and include engaging in at least 150 minutes of MVPA per week over the course of 3 days, with no more than 2 consecutive days without activity (ADA, 2018). Additionally, the ADA recommends two to three days per week of resistance training on nonconsecutive days (ADA, 2018). For these recommendations, adults are considered to be between the ages of 18-64 and older adults are considered to be 65 years of age or older (USDHHS, 2018). T1Ds have been advised to continuously monitor their A1C levels and blood glucose levels to try to stay within healthy ranges; T1D individuals have sustained benefits of improved blood glucose control

reflected in their A1C levels and the number of times their blood glucose was in target range after completing forms of physical activity such as resistance training (Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group, 2009).

In 2017, exercise recommendations were released for T1Ds in the Elsevier Journal of Medical Hypotheses on the basis that a training program could be composed of a combination of high intensity interval training and strength training and potentially decrease the exercise-associated rapid drop of glycaemia in T1D (Farinha, Krause, Rodrigues-Krause, & Reischak-Oliveira, 2017). T1Ds were recommended to combine strength training and high intensity interval training (HIIT) for at least two months, three times per week, in order to elicit health benefits (Farinha et al., 2017). Specifically, it was suggested that T1Ds combine hypertrophic strength exercises and an exercise protocol including ten 60s intervals at 90% heart rate max interspersed with 60s of recovery in the same session (Farinha et al., 2017). Still, recommending different types and intensities of physical activity is different than understanding actual physical activity behaviors among diabetic populations.

The Integrated Theory of Health Behavior Change (ITHBC) suggests that health behavior changes can be improved by advancing knowledge and beliefs, building self-regulation skills, and boosting social facilitation (Ryan, 2009). Limited ITHBC research has explored physical activity and T1D, although literature exists for the ITHBC and T2D where it has been demonstrated that culturally focused diabetes management educational workshops were successful in increasing diabetes self-management knowledge (Flores, 2018). Engagement in self-management behaviors are seen as the proximal outcome that influences the distal outcome of improved health status (Ryan, 2009). Interventions can be directed at factors such as increases in knowledge and beliefs, self-regulatory skills, and social facilitation in order to elicit a physical

activity focused behavior change. Validated self-report measures have been created (e.g., Barriers to Physical Activity in Type 1 Diabetes (BAPAD-1) scale) to identify perceived physical activity barriers for those with diabetes, but none exist for the surrounding interpersonal influences affecting physical activity behaviors of diabetics (Brazeau et al., 2012). Other measures exist for diabetics (e.g., Diabetes Attitude Scale, which measures need for special training in diabetes care, seriousness of T2D, value of tight glucose control, psychosocial impact of diabetes, and attitude toward patient autonomy; Anderson, Fitzgerald, Funnell & Gruppen, 1998) yet limited research has gathered detailed information on physical activity behaviors of T1D and T2D populations, as well as the multiple levels of influence that affect them, leaving a gap in the literature (Michigan Diabetes Research Center, 1998).

The aim of this study is to compare physical activity behaviors, including exercise, of T1Ds to T2Ds and ND adults, while also exploring how self-reported physical activity behaviors fit into the ITHBC framework of knowledge and beliefs, social facilitation, self-regulation skill and ability, engagement of self-management behavior, and health status. By using a theoretical framework, we can better explain the meaning, nature and challenges associated with the physical activity behaviors of people with T1D. This knowledge can then be used to address challenges associated with physical activity in more informed and effective ways. Current literature reports a large amount of T2D's that are not reaching physical activity guidelines; further reports have shown that the physical activity levels of T1D adolescents have no differences from adolescents without T1D (Zhao et al., 2008; Kaminsky & Dewey, 2014). Therefore, we hypothesize that T1D populations will report more average moderate and vigorous aerobic minutes per week and average days per week of strength training than T2D.

Chapter 3 - Methods

Design and Participants

This study used a cross-sectional survey design to study differences in physical activity behaviors between T1D, T2D, and ND adults. The survey was advertised via university newsletter (K-State Today) to all of Kansas State University's students, faculty, and staff on the day the survey became open to the public. The survey continued to be advertised on social media (May-July, 2019). Facebook posts were created and shared within the Manhattan, KS, community; in the Kansas City, KS area; and also on diabetic Facebook pages marketing the survey. The survey continued to be advertised via Instagram through shared stories and messages, as well as through Twitter via Tweets and was mobile device friendly.

Participant inclusion criteria included being between the ages of 18-64, able to complete survey questions in English, and having the ability to complete physical activity or exercise. Exclusion criteria included having a physical or mental condition prohibiting exercise or physical activity participation. To be considered part of the diabetic populations versus non-diabetic, participants must have had their diabetes diagnosed at least 6 months prior to completing the survey and specify whether they had been diagnosed with T1D or T2D.

The survey was open for 8 weeks, May 14 – July 8, 2019. Using the online survey platform Qualtrics participants filled out screening eligibility followed by informed consent, if eligible. The survey included a combination of questions from standardized surveys and questions developed specifically for this study and pilot tested with individuals from the included populations. The complete survey is provided in Appendix A. The standardized instruments used in the survey included the Department of Defense Health Related Behaviors Survey of Active

Duty Military Personnel (DoD, 2011) and the Behavior Risk Factor Surveillance System (CDC, 2018a).

Survey and Measures

The survey was branched, so that ND participants completed one branch that included 36 questions and T1D/T2D participants completed the other branch with 50 questions. After truncating survey responses at 5000 second (i.e., 83 minutes; 95% of responses), on average, it took ND 15:05 ± 11:58 minutes and T1D/T2D 20:12 ± 15:34 minutes to complete their respective survey branches. Although this difference was statistically significant ($t = 2.55$, $p = .013$), completion rates were similar for each survey branch ($\chi_2 = .083$, $p > .05$).

Knowledge and Beliefs.

Knowledge and beliefs are the first of five constructs in the ITHBC (Ryan, 2009). Since knowledge is characterized as condition-specific factual information (Ryan, 2009), diabetic participants were specifically asked if they knew when their blood glucose was too high, with yes or no as the answer options. Beliefs are characterized as personal viewpoints about specific health conditions or behaviors (Ryan, 2009). To assess beliefs, diabetic participants were asked "How satisfied are you with your supplied education on diabetes?" Participants responded using a 7-point Likert scale ranging from 1-extremely satisfied to 7-extremely dissatisfied. An over-arching question addressing the desire to increase knowledge and beliefs was "What would you like to learn about exercise and physical activity in relation to your health?" with yes or no being the answer choices. If yes was selected, participants were then asked to please type in their response in an answer caption.

Social Facilitation.

Social facilitation includes social influence (e.g., when a knowledgeable person often in a perceived position of authority persuades thoughts and motivation), social support, and negotiated collaborations between the individual, their family, and/or health care professionals, ultimately leading to behavior change (Ryan, 2009). In order to measure this, the survey asked diabetic participants who helped them manage their diabetes. Participants had the option to select all from no-one, family, co-workers, health-care providers, support groups and other (specify). Additionally, the survey questioned all participants yes/no if anyone had told them to not participate in certain kinds of physical activity or exercise and if their health care provider had warned them to not participate in certain forms of physical activity or exercise. If participants answered yes, they then were asked to explain the kind of physical activity or exercise they had been warned against doing.

Self-Regulation Skill & Ability.

Self-regulation is characterized by goal setting, self-monitoring and reflective thinking, decision making, planning, plan enactment, self-evaluation and lastly management of emotions that occur during a change (Ryan, 2009). These processes are used as individuals integrate a behavior change into their daily lives (Ryan, 2009). In order to measure self-regulation, all participants were asked 1) Do you actively engage in goal setting for your health? 2) If yes, what are your current health related goals? Diabetic participants were also asked to rate their self-efficacy (confidence in one's ability) to learn about diabetes and make lifestyle changes in order to improve their health; answer options included not at all, somewhat, and very.

Engagement in Self-Management Behavior

Engagement in self-management behaviors is influenced by knowledge and health beliefs (Ryan, 2009). Self-regulation is a skill that facilitates practicing self-management behavior. By

adopting self-regulation skills and abilities, individuals can enhance their self-management and in turn have a direct and positive effect on their health status. The survey measured self-management behaviors by asking all participants what they did to prepare to participate in physical activity or exercise. All participants answered a slightly modified series of questions regarding their physical activity behaviors from the Department of Defense health related behaviors survey (Meadows et al., 2018). First, they were asked to report the number of days in the past 30 that they did moderate, vigorous, and strength training physical activities; answer options ranged from not at all in the past 30 days to about every day. Then, they were asked to report the average minutes per day they typically did moderate and vigorous physical activities. Total physical activity levels were reported in the format of average minutes per week of moderate and vigorous aerobic activity and average days per week of strength training. Then, participants were asked to explain what they did after physical activity or exercise to take care of their diabetes/yourself. Exercise preferences were also identified in a series of two questions asking participants 1) Which do you prefer more: resistance training, aerobic training, both equally, other (specify); and 2) Please explain your preference for the type of activity you chose in the previous question.

Health Status

Health status is defined as an individual's relative degree of wellness or illness; proper management of chronic conditions benefits individuals as it improves their health status and wellness (Ryan, 2009). Due to the survey methods used, this was determined by asking participants their diabetes status and pre-diabetes status. Diabetes status was measured as being either T1D, T2D, or ND. If participants answered that they were non-diabetic, they were then

provided a follow-up question regarding if they had or had not been previously diagnosed with pre-diabetes.

Demographics

Participants first indicated their gender (male or female) followed by providing their age. Participants were also asked to provide their race and ethnicity.

Procedures

All participants accessed the survey online via a single link through bitly (http://bit.ly/t1dmt2dm). Participants first completed three screening questions to determine eligibility, indicated their consent to participate, and then completed the survey. After survey completion, participants were redirected to a separate survey where they could enter their email for a chance to win one of eight Amazon gift cards of up to a $75 value. Data were downloaded as an SPSS file from Qualtrics for analysis.

Data Analysis

Based on previous research that examined differences in self-reported physical activity by diabetes status, to have 80% power, we needed to have 33 participants/group (total N=99 for all 3 groups) and to have 90% power required 43 participants/group (total =129 for all 3 groups) (Chow, Shao, Wang, & Lokhnygina, 2017; D'Agostino, Chase, & Belanger, 1988; Fleiss, Levin, Paik, 2003; Machin, Campbell, Foyers, & Pinol, 1997). Descriptive analyses were completed using SPSS version 25 (IBM; Armonk, NY) including sample means, standard deviations, and frequencies for comparisons between groups and their responses for variables comprising the ITHBC. For hypotheses testing, one-way ANOVAs were run to determine differences between groups (T1D, T2D, ND) for self-reported physical activity reported in weekly minutes per week of aerobic activity (moderate and vigorous) and days per week of strength training activity.

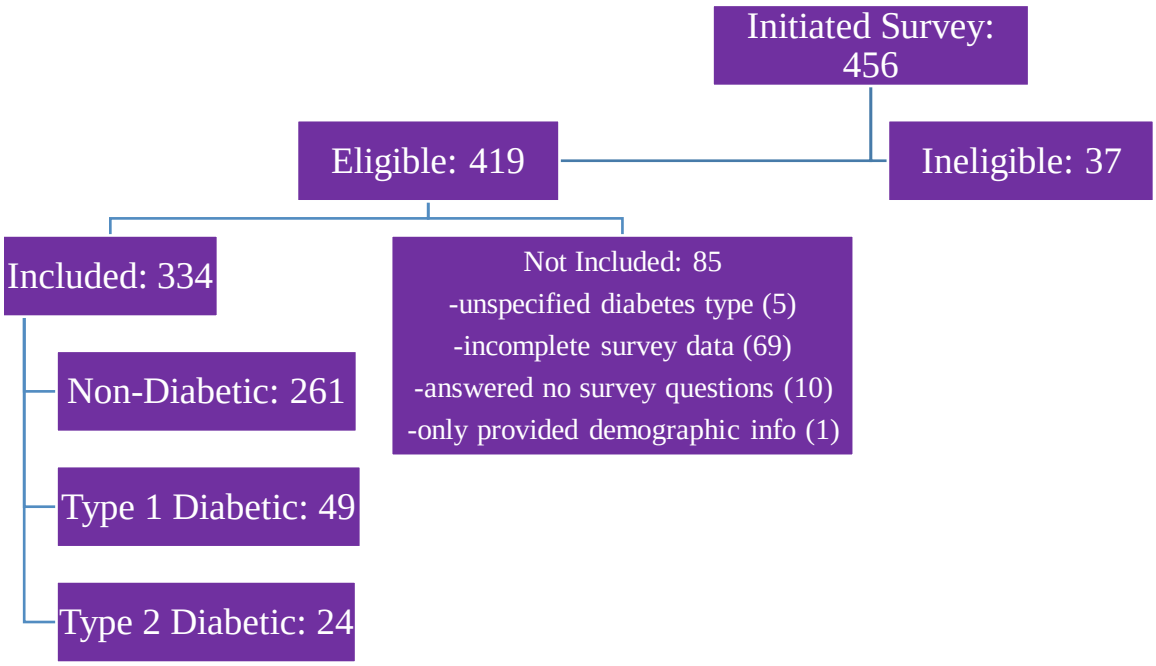
Games-Howell post hoc tests were used to analyze the results due to unequal sample sizes (RPubs, 2016).

Chapter 4 - Results

Survey Response Rate

There were 615 total clicks on the survey link. Of those, 456 individuals initiated the screening questions. Thirty-seven were ineligible based on age (n = 12), inability to do physical activity or exercise due to a mental or physical condition (n = 22), not completing the screening questions (n = 2), or not agreeing to participate in the survey (n = 1). The remaining 419 consented to the survey. Excluded from the analyses were 10 participants who answered no survey questions, one participant who only provided demographic information, five participants who did not specify their type of diabetes, and those with incomplete survey data (n = 69), leaving a total of 334 valid responses (T1D = 49, T2D = 24, and ND = 261). See Figure 4-1 for a breakdown of survey responses. The remainder of this results section includes data from the 334 participants as specified below.

Figure 4-1 Survey Responses



Demographics

Participant demographic characteristics are presented in Table 4-1. The majority of participants were women (79.6%, n = 266) and white (89.5%, n = 299). The mean age of T1D participants was 27.1 (± 9.0) years, T2D was 52.6 (± 10.3) years, and ND was 33.8 (± 12.9) years.

Table 4-1 Participant Demographics by Diabetes Status Groups

	Type 1 Diabetics (n = 49)		Type 2 Diabetics (n = 24)		Non-Diabetics (n = 261)	
Characteristic	**N (%)**	**M (SD)**	**N (%)**	**M (SD)**	**N (%)**	**M (SD)**
Gender						
Male	9 (18.4)	--	7 (29.2)	--	52 (19.9)	--
Female	40 (81.6)	--	17 (70.8)	--	209 (80.1)	--
Age (years)	--	27.1 (9.0)	--	52.6 (10.3)	--	33.8 (12.9)
Race						
White	46 (93.9)	--	20 (83.3)	--	233 (89.3)	--
Black	1 (2.0)	--	--	--	4 (1.5)	--
American Indian or	--	--	1 (4.2)	--	1 (0.4)	--
Alaskan Native	--	--	--	--	--	--
Asian	1 (2.0)	--	1 (4.2)	--	10 (3.8)	--
Native Hawaiian or	--	--	1 (4.2)	--	--	--
Other Pacific Islander	--	--	--	--	--	--
Mixed Race	--	--	--	--	9 (3.4)	--
Other	1(2.0)	--	1 (4.2)	--	3 (1.1)	--
Ethnicity (Hispanic or Latino)	2 (4.1)	--	2 (8.3)	--	18 (6.9)	--

Hypothesis Testing: Comparison of Physical Activity Levels

Participants' physical activity levels are shown below in Table 4-2. Participants reported their average weekly minutes of moderate aerobic activity (T1D =179.0 ± 171.7; T2D = 109.2 ± 88.2, ND = 215.7 ± 186.6) and vigorous aerobic activity (T1D = 66.3 ± 80.0; T2D = 41.7 ± 60.5; ND = 73.8 ± 94.8). They also reported their weekly days of strength training (T1D = 1.8 ± 2.0, T2D = 0.7 ± 1.0, and ND = 1.5 ± 1.7). One-way ANOVAs, with Games-Howell post hoc tests were used to determine differences in aerobic activity and strength training between T1D, T2D,

and ND participants. Statistically significant differences existed for moderate aerobic activity between groups, $f(2, 304) = 3.9$, $p = 0.021$, where T2D reported significantly fewer weekly minutes than ND (mean difference = 106.5, $p < .001$). No significant differences were found between groups for weekly vigorous aerobic activity (p=0.242). Strength training days/week differed significantly between groups, $f(2, 314) = 3.6$, $p = 0.028$ with T1D reporting significantly more days/week than T2D (mean difference = 1.1, $p = .005$).

Table 4-2 Average Aerobic Minutes/Week and Strength Training Days/Week by Diabetes Status

Characteristic	Type 1 Diabetics (n = 49) M (SD)	Type 2 Diabetics (n = 24) M (SD)	Non-Diabetics (n = 240) M (SD)
Weekly Minutes of Moderate Physical Activity	(179.0±171.0)	(109.2±88.8)	(215.7±186.6)*
Weekly Minutes of Vigorous Physical Activity	(66.3±80.0)	(41.7±60.5)	(73.8±94.8)
Number of Days Per Week of Strength Training	(1.8±2.0)*	(0.7±1.0)	(1.5±1.7)

* Reported significantly more than Type 2 Diabetics, $p < 0.05$

Descriptive Results for ITHBC Constructs

Knowledge and Beliefs

The majority of diabetic participants, 79.6% of T1D and 54.2% of T2D, reported being knowledgeable enough about their bodies to sense high blood glucose (see Table 4-3). About 1/3 of T1Ds and T2Ds felt moderately satisfied with their exercise knowledge. The majority of each group (T1D = 69.4%; T2D = 58.3%; ND = 61.3%) wanted to gain further exercise knowledge. Table 4-4 provides further information about what T1D, T2D, ND reported in response to the question 1) What would you like to learn about exercise and physical activity in relation to your health?

Table 4-3 Knowledge and Belief Survey Frequencies

Characteristic	Type 1 Diabetics (n = 49) N (%)	Type 2 Diabetics (n = 24) N (%)	Non-Diabetics (n = 261) N (%)
Knowledge of increase in blood glucose Yes:	39 (79.6)	13 (54.2)	--
Satisfied with current exercise & diabetes knowledge			
Extremely satisfied:	5 (10.2)	4 (16.7)	--
Moderately satisfied:	17 (34.7)	8 (33.3)	--
Slightly satisfied:	6 (12.2)	2 (8.3)	--
Neither satisfied nor dissatisfied:	7 (14.3)	4 (16.7)	--
Slightly dissatisfied:	5 (10.2)	2 (8.3)	--
Moderately dissatisfied:	1 (2.0)	1 (4.2)	--
Extremely dissatisfied:	2 (4.1)	2 (8.3)	--
Would like to gain exercise knowledge	34 (69.4)	14 (58.3)	160 (61.3)

Table 4-4 Participant Responses to Gaining Exercise Knowledge

Q: Has anyone (including health care provider) had told you to not participate in certain kinds of physical activity or exercise? If yes, please specify.	
Categories/Themes	**Participant Responses**
Blood Glucose	"Effects of various exercises on blood sugar. And weight." "What are the best ways to keep blood sugar steady during activity" "How to better prevent hypoglycemia in aerobic exercise. I feel like I always go low on long runs and always have to eat fast acting carbs during a run" "How different combinations like in CrossFit can help with spikes and drops during the workout" "Intensity level and duration that lead to lows vs. intensity level and duration that end in highs from burning fat."
Finances	"How incorporate it without costing money"
Physical activity/Exercise guidelines	"If I am doing enough to be healthy" "I guess is there a minimum amount that can be done, or can I do it with my child?" "I'm fascinated by this area - it would be great to know if there are particular types of activities, length, times of day, quantity per week, or other factors, that research suggests are

	better or worse for Type I diabetics. I firmly believe there's a distinct difference between Type I and Type II with regard to this area, so I would pay more attention to research and information that recognizes these differences." "Does exercise really contribute to longevity? When is enough exercise enough?"
Specific Recommendations	"I'd like to set some running/workout/strength conditioning goals with someone who understands fibromyalgia/chronic pain and how that can impact someone's relationship to physical exercise (even though I'm not actively dealing with serious symptoms). The trainers I've been around at the rec seem to have a mentality that pushing yourself really, really hard is the only way to engage in physical activity." "What weights and movements I should/could be lifting to get some strength back without exacerbating my back issues. I want to get back into the gym, but my confidence to do so safely is pretty low."

Social Facilitation

As shown in Table 4-5, participants with T1D mostly received help from their family (38.8%) or health care providers (37.6%) for managing their diabetes, while the majority of T2D received this help from their health care providers (54.2%). In general, 14.3% of T1D, 8.3% of T2D, and 10% of ND participants reported being told to not participate in certain forms of physical activity or exercise, while 2.0% of T1D, 20.8% of T2D, and 10.3% of ND participants reported that their health care provider warned them against curtain kinds of physical activity or exercise. Table 4-6 provides further details regarding the types of activity participants were cautioned not to do.

Table 4-5 Social Facilitation Survey Response Frequencies

	Type 1 Diabetics (n = 49)	**Type 2 Diabetics (n = 24)**	**Non-Diabetics (n = 261)**
Characteristic	**N (%)**	**N (%)**	**N (%)**

Who helps you manage your diabetes?			
No-one:	15 (30.6)	5 (20.8)	
Family:	19 (38.8)	7 (29.2)	
Co-workers:	3 (6.1)	1 (4.2)	
Healthcare provider:	18 (36.7)	13 (54.2)	
Support group:	3 (6.1)	1 (4.2)	
Other:	10 (20.4)	--	
Have you been told to not participate in certain kinds of exercise or physical activity?			
Yes:	7 (14.3)	2 (8.3)	26 (10.0)
No:	36 (73.5)	20 (83.3)	189 (72.4)
Not sure:	--	1 (4.2)	6 (2.3)
Has your healthcare provider warned you about participating in certain forms of physical activity or exercise?			
Yes:	1 (2.0)	5 (20.8)	27 (10.3)
No:	42 (85.7)	18 (75.0)	194 (74.3)

Table 4-6 Sample of Participant Responses: Please list who and what forms of activity you were told not to participate in?

Q: Please list who and what forms of activity you were told not to participate in?
Participant Responses
Coaches and people lacking the knowledge on how to handle a diabetic on a team involved in physical activity. More of a safety concern since they don't know what to do if something was to go wrong.
I was told I could never make it through Fire School and I did.
Running long distance
People in the dorms, and pretty much any and every form because they don't know anything about diabetes and they get scared.
Playing for the soccer team in high school.

Self-Regulation Skill & Ability

Participants varied in their rates of active goal setting for their health (T1D = 57.1%; T2D = 37.5%; ND = 46.7%) as shown in Table 4-7. Current health goals for T1D included improving A1C numbers, better blood glucose control, increased exercise participation, improving nutrition, and weight loss. Current health goals for T2D included weight loss, lowering AIC number, and increased exercise participation. ND participants reported health goals such as improved nutrition, improved exercise participation, improved body composition, weight loss, increase strength, participate in new fitness challenges, and improved quality of life. The majority of diabetic participants (T1D = 59.2%; T2D = 58.3%) felt very confident in their abilities to make lifestyle changes to improve their diabetes health.

Table 4-7 Self-Regulation Skill & Ability Survey Response Frequencies

Characteristic	Type 1 Diabetics (n = 49) N (%)	Type 2 Diabetics (n = 24) N (%)	Non-Diabetics (n = 261) N (%)
Participates in active goal setting for health	28 (57.1)	9 (37.5)	122 (46.7)
Has current health goals	28 (57.1)	9 (37.5)	121 (46.4)
Confidence in one's ability to make lifestyle changes to improve diabetes health			
Not at all confident:	--	1 (4.2)	--
Somewhat confident:	14 (28.6)	8 (33.3)	--
Very confident:	29 (59.2)	14 (58.3)	

Engagement in Self-Management Behavior

The majority of respondents (T1D = 89.8%; T2D = 50.0%; ND = 80.5%) reported participating in exercise preparation behaviors and (T1D = 93.9%; T2D = 62.5%; ND = 86.2%)

post-exercise care behaviors (See Table 4-8). Examples of pre- and post-exercise care behaviors reported by participants are shown in Table 4-9.

Table 4-8 Engagement in Self-Management Behaviors Survey Response Frequencies

Characteristic	Type 1 Diabetics (n = 49) N (%)	Type 2 Diabetics (n = 24) N (%)	Non-Diabetics (n = 261) N (%)
Participated in exercise preparation behaviors	44 (89.8)	12 (50.0)	210 (80.5)
Participated in post-exercise care behaviors	46 (93.9)	15 (62.5)	225 (86.2)

Table 4-9 Pre and Post-exercise behaviors

Q: What do you do to prepare to participate in physical activity or exercise (i.e. check blood sugar, take supplements, drink juice, other, etc.)? Please type in your response below.	
Categories/Themes	**Participant Responses**
Nutrition	**T1D:** "BCAA/check blood glucose" "Check blood sugar and correct as necessary with carbohydrates" "check blood sugar, eat snack if needed, lower basal rates before exercise" "for most all runs, I eat ½ cup cottage cheese and 1 banana" **T2D:** "check blood sugar, drink water" "try to eat protein" **ND:** "avoid eating or drinking for a few hours prior" "change clothes, drink water" "drink water all day long"
Warm-Up Activities	**T2D:** "drink water, stretch" **ND:**

	"drink water and stretch for 5 minutes" "drink water and stretch muscles"
Relaxation techniques	**T1D:** "Deep breathing" **ND:** "Meditate"
Q: What do you do after physical activity or exercise to take care of your diabetes? (i.e. check blood sugar, take supplements, drink juice, other, etc.) Please type in your response below.	
Categories/Themes	**Participant Responses**
Nutrition	**T1D:** "Check blood glucose, drink eater, have a snack/eat a meal" "Check blood sugar, calibrate Dexcom, eat if I'm going low, drink water" **T2D:** "Eat a high protein meal, drink water" "water, healthy snack" **ND:** **"**drink water and eat protein" "drink water, eat a snack"
Cool-off	**T2D:** "Stretch, drink water" **ND:** "Supplements, cool-down."
Cleanliness	**ND:** "Stretch, hydrate, eat, walk, cool shower" "cool down period" "drink water, shower"
Relaxation Techniques	**T1D:** "Deep breathing exercise" **ND:** "Meditation and stretch"

When participants were asked to report their exercise preferences, walking and resistance training (weightlifting and strength training) were the most common forms of physical activity and exercise participants reported participating in. Note that participants could list more than one

preferred type. The exercise preferences reported are represented in the bar graphs below in Figure 4-2 through Figure 4-4. While walking was the most preferred activity across all groups, T1D reported a significantly greater amount of participation in resistance training than T2D. ND's second most popular form of activity was also resistance training. ND participants had the greatest variety of activities, with T1D coming in a close second, and T2D coming in last for how scarce of activities their population completed.

Figure 4-2 T1D Exercise Preferences

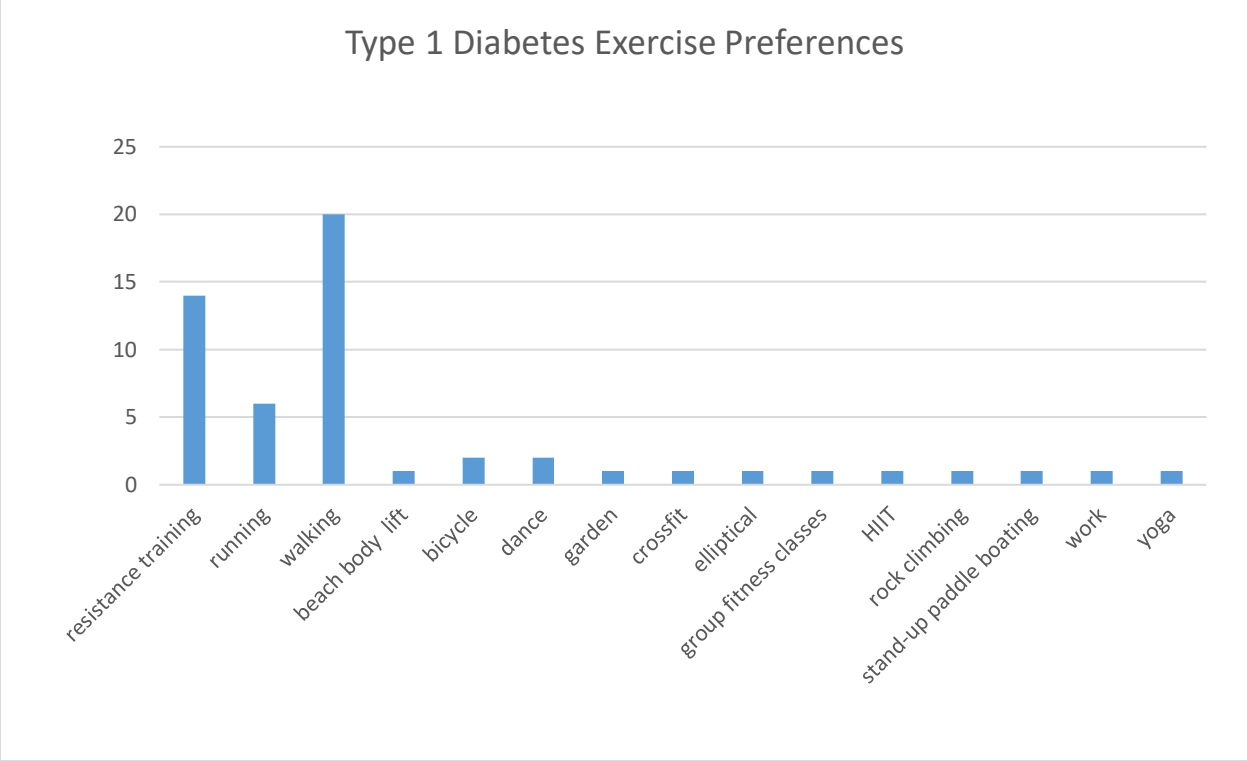


Figure 4-3 T2D Exercise Preferences

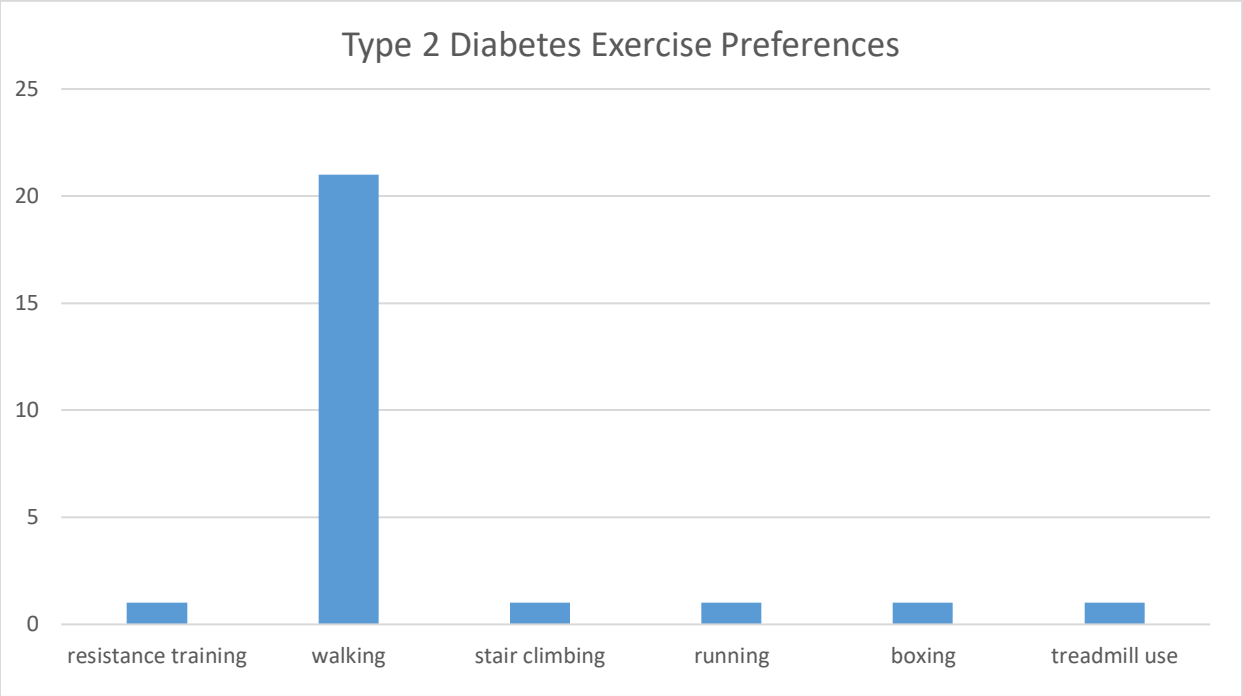
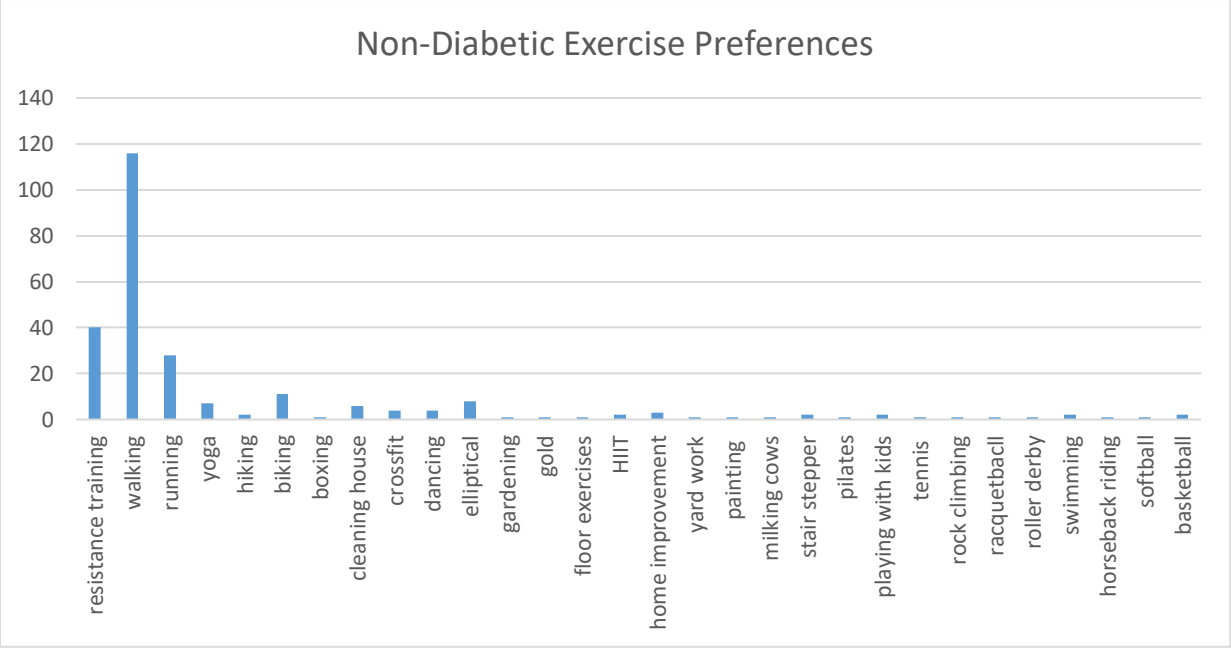


Figure 4-4 ND Exercise Preferences



Health Status

As shown in Table 4-10, the majority of participants were ND (78.1%) with 13 of those (5.0%) being pre-diabetic. Over 21.9% were diabetic including, 49 T1D (14.7%) and 24 T2D (7.2%).

Table 4-10 Health Status Survey Response Frequencies

Characteristics		N (%)
Diabetes Status	Type 1 Diabetes:	49 (14.7)
	Type 2 Diabetes:	24 (7.2)
	Pre-Diabetes:	261 (78.1)
	Non-Diabetic:	13 (3.9)

Chapter 5 - Discussion

Tens of millions of Americans have either T1D or T2D (CDC, 2017a). Due to small sample sizes, limited data are available for physical activity behaviors of adults with T1D. Therefore, this study compared physical activity and exercise behaviors of adults with T1D to those with T2D and NDs while also examining how the responses from each group fit into the ITHBC framework and its constructs (knowledge and beliefs, social facilitation, self-regulation skill and ability, engagement of self-management behavior, and health status). The hypothesis that T1D populations would report more average moderate and vigorous aerobic minutes per week and average days per week of strength training than T2D was partially supported in that T1Ds reported significantly greater days of strength training per week than T2Ds. In addition, ND reported significantly more average moderate aerobic minutes per week than T2D. T1D's average aerobic minutes per week was above the recommendations and had decent (although not at recommended levels) of average vigorous aerobic minutes per week. T1D's also managed to meet the recommendations for strength training, reporting the most average days per week out of all three groups.

The differences in self-reported exercise levels of T1Ds and T2Ds were of interest to study due to both of these populations seeing increases in obesity (Polsky & Ellis, 2015). Overall, recent reports have been showing increases in overweight and obesity in diabetic populations, along with lower rates of physical activity for individuals T2D as reflected in the results of this study (Smyth & Heron, 2006). These lower levels of physical activity by the T2D population are unfortunate since lifestyle behaviors such as physical activity and exercise are recommended as both primary prevention and tertiary treatment strategies for those with T2D (Booth, Roberts, & Laye, 2011). In fact, physical activity and exercise have been reported as the

primary prevention for the major risk factors (e.g., impaired metabolism, low-grade inflammation, obesity) of diabetes (Booth et al., 2011). Primary prevention of T2D risk factors is possible for almost all humans via physical activity and exercise participation up to approximately 70 years of age (Booth et al., 2011). Due to the majority of T2D populations in the US and within this study not doing enough physical activity despite the benefits, further work needs to be done in order to try and increase their physical activity levels.

There were not any statistically significant differences between physical activity levels for T1Ds and NDs within our sample population. Recent research found similar physical activity levels of T1D adolescents and ND adolescents (Kaminsky & Dewey, 2014). As our sample of T1D were younger in age than T2D, these differences may be due to age differences in physical activity as reported by Whitfield and associates (2019) in addition to diabetes type.

An examination of survey responses to items within the ITBHC framework showed for knowledge and beliefs that the majority of diabetic participants reported knowing when their blood glucose increased. Around 1/2 of T1D and T2D participants felt extremely or moderately satisfied with their current exercise knowledge, while the majority of all participants wanted to gain more exercise knowledge. Participants commented that they knew physical activity and exercise were good for them, but they would like to learn how they should participate or how it would affect their immediate health. Many T1D participants responded that most of their exercise knowledge was self-taught. This partially reflects previous research that identified barriers to exercise and physical activity for those with T1D were the same as their non-diabetic counterparts, with the exception that T1D reporting the need for education about the effects of exercise on diabetes control and its complications (Lascar et al., 2014). Similar findings were found for T2Ds, where T2Ds reported having adequate knowledge of the benefits of physical

activity and exercise on their blood glucose control, yet they had poor practices of participation (Awotidebe, Adedoyin, Afolabi, & Opiyo, 2016). This can be seen reflected within the results, where T2D participants reported knowing the benefits of physical activity and exercise yet still chose to not participate. This could potentially mean diabetic, primarily T1D, and ND populations could benefit from acquiring more exercise knowledge (recommendations on intensity, type, frequency; common physiological responses to expect). Of note, many diabetes educators have reported that they are poorly trained and lack the skills, expertise, and knowledge necessary to counsel their patients over physical activity and exercise (Shields et al., 2013). Therefore, a future focus should be on educational practices these diabetes educators can complete so they can better help their patients. By acquiring further knowledge on physical activity and exercise, T1D and T2D populations could possibly become more active and increase their minutes of aerobic activity and days per week of strength training. Those who are knowledgeable of their high blood glucose have the potential to learn more about physical activity and exercise and how that can help manage blood glucose levels.

Previous research has found significant and positive relationships between treatment adherence with diabetic patients and their level of social support, specifically for the importance of social support from family providing practical help to those with T1D or T2D that reduced the stress of living with the diseases (Miller & DiMatteo, 2013). Family support was reflected within our study, particularly for those with T1D who were almost 10% more likely to report receiving help from family members with their diabetes management than those with T2D. Although many participants responded that they received help from their healthcare providers, recent studies suggest that healthcare providers may not be knowledgeable enough to be giving suggestions. For example, a 2016 study surveyed healthcare providers over their knowledge and confidence in

providing physical activity and exercise guidance to T1Ds found that providers had received little to no formal training over physical activity and exercise for those with T1D, therefore having limited knowledge on specific guidelines or recommendations to provide (Knight, 2016). Despite this, participants still felt somewhat confident in their ability to guide T1D patients (Knight, 2016). In the future, research could examine the effectiveness of regular discussion of physical activity and exercise at the doctor's office and how that affects patients' physical activity levels, particularly those with diabetes. The difference between healthcare providers' knowledge and confidence in providing guidance to T1Ds about physical activity and exercise brings concerns about the accuracy of the information being relayed (Knight, 2016). Future research could examine the recommendations that diabetes specialists commonly provide to their patients.

Self-regulation skill and ability responses showed that over half of T1D participated in active goal setting and had current health goals, while 46.7% of ND and only 37.5% of T2D did so. T1D and T2D both shared current health goals of: improving A1C numbers, better blood glucose control, increased exercise participation, improved nutrition, and weight loss. ND participants had similar goals, but with more fitness based goals such as participating in a 5k race or reducing running times. Both T1D and T2D participants reported feeling very confident in their abilities to make lifestyle changes for their diabetes health, which may reflect the social facilitation they reported receiving from family members or their healthcare providers. The social support allows the stress associated with lifestyle changes to be reduced by providing practical help (Miller & DiMatteo, 2013). Goal setting has been widely used in interventions, therefore future research should dive deeper into other factors associated with the populations when setting goals, such as age since fewer of our T2D participants who tended to be older

reported setting goals. Studies have been published over the effectiveness of goal setting in older populations (Hobbs et al., 2013). Goal setting interventions in populations between the ages of 55-70 years of age resulted in long term improvements in physical activity (Hobbs et al., 2013). Many of the goals that were set by diabetic participants were for better blood glucose control, A1C numbers, weight-management, and exercise participation. Practicing healthy behaviors such as exercise to address these goals has the potential to improve health and reduce secondary symptoms of diabetes (USDHHS, 2018).

Participant engagement in self-management behaviors was high in this sample. The majority of participants in each group reported practicing pre-exercise preparation behaviors as well as post-exercise care behaviors. These high percentages among those with T1D and ND may reflect that many were reporting enough weekly minutes of aerobic and strength training physical activity to meet the current guidelines (USDHHS, 2018). As well, exercise preparation behaviors seemed to reflect the recommendation by healthcare providers for diabetic individuals to ingest pre-exercise carbohydrates in order to prevent a drop in blood glucose (Senter, Appelle, & Behera, 2013). Walking was reported as the most common form of physical activity and exercise by all three groups, and resistance training was next common among T1D and ND participants. These results line up similarly to the National Health and Nutrition Examination Survey responses that reported walking as the most frequently reported form of activity for men and women in the US (Dai et al., 2015). T1D and ND were able to meet physical activity guidelines, primarily reporting walking and strength training as their primary exercise preferences. Although both of these populations met guidelines, T1D reported more strength training days (T1D = 1.8 ± 2.0 and ND = 1.5 ± 1.7). This could be due to the slight differences in exercise preferences by these populations. Both populations reported walking as one of their

main exercise preferences, but T1Ds reported more strength training preferences than NDs did. Conversely, NDs reported running more as an exercise preference as compared to T1Ds. This could potentially be due to T1Ds fear of hypoglycemia that can occur while running (Senter et al., 2013).

Health status for this sample was only denoted by diabetes status. Most of those who were involved were ND (78.1%) with 5% of those ND being pre-diabetic. This 5% is much lower than the national estimates which are 33.9% of adults, but this could be due to under-diagnosis of pre-diabetes (National Institute of Diabetes and Digestive and Kidney Diseases, 2017). There were a total of 21.9% participants with diabetes including 49 with T1D and 24 with T2D.

The data collected within this study may be useful to help inform future behavior change interventions. All populations responded that to a varying degree they all wanted to add to their knowledge of physical activity and exercise. By addressing aspects of the ITHBC through targeting exercise behaviors within its constructs, it is possible to reinforce behavior change and ultimately improve the health of people with diabetes, potentially even reversing T2D.

Study strengths included sufficient statistical power to compare T1D with T2D and ND participants, despite having slightly fewer T2D than the initial power analysis. Another strength is that while previous research has explored physical activity levels, complete examination of behavioral factors related to key behavioral constructs of the ITHBC has not been previously done. Many of the survey questions were formulated specifically for those with diabetes (T1D and T2D) and were reviewed by a variety of individuals with subject matter expertise including: T1D individuals, an endocrinologist, nurses that work in diabetes clinics, university students, and individuals without diabetes. This process of verification by multiple categories of individuals

helped ensure question readability and understanding. Additional validated tools were used such as the Department of Defense Health Related Behaviors Survey of Active Duty Military Personnel (Meadows et al., 2018).

Study limitations included under-recruitment of T2D participants. Although 33 T2D consented to participate, only 24 responses were valid for analysis. Another potential limitation was self-selection bias, where people practicing physical activity and exercise behaviors may have been more likely to respond, limiting external validity. Increases in response rates for T1D participants seemed to follow social media posts on Instagram via pages used for tracking weight-loss from physical activity and exercise, diet or both. Some individuals that were individually asked to participate in the survey refused to because they felt their complete lack of physical activity did not provide much feedback. Future research could focus on recruiting participants outside of social media that may not already be on a weight-loss track in order to get more representative responses. Additional questions pertaining to specific characteristics (such as number of years since diabetes diagnoses) could be used to better categorize participants in the future to conduct additional analyses to further differentiate differences in physical activity-related behaviors over time. Future studies could also look to examine more differences in physical activity and exercise behaviors in similar populations but with comparisons by age. Collecting data over different times of the year may also provide a better understanding of influences on physical activity behaviors when considering the influence of weather on physical activity behaviors.

References

American Diabetes Association. (2018) Standards of medical care in diabetes. *The Journal of Clinical and Applied Research and Education,* 41(1), 13-44.

American Diabetes Association. (2019). Statistics about biabetes. Retrieved from https://www.diabetes.org/resources/statistics/statistics-about-diabetes

American Diabetes Association. (2013). Economic costs of diabetes in the US in 2012. *Diabetes Care*, *36*(4), 1033-1046.

Anderson, R. M., Fitzgerald, J. T., Funnell, M. M., & Gruppen, L. D. (1998). The third version of the Diabetes Attitude Scale. *Diabetes Care*, *21*(9), 1403-1407.

Awotidebe, T. O., Adedoyin, R. A., Afolabi, M. A., & Opiyo, R. (2016). Knowledge, attitude and practice of exercise for plasma blood glucose control among patients with type-2 diabetes. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, *10*(2), S1-S6.

Bhupathiraju, S. N., & Hu, F. B. (2016). Epidemiology of obesity and diabetes and their cardiovascular complications. *Circulation Research*, *118*(11), 1723-1735.

Booth, F. W., Roberts, C. K., & Laye, M. J. (2011). Lack of exercise is a major cause of chronic diseases. *Comprehensive Physiology*, *2*(2), 1143-1211

Brazeau, A. S., Mircescu, H., Desjardins, K., Dube, M. C., Weisnagel, S. J., Lavoie, C., & Rabasa-Lhoret, R. (2012). The Barriers to Physical Activity in Type 1 Diabetes (BAPAD-1) scale: predictive validity and reliability. *Diabetes & Metabolism*, *38*(2), 164-170.

Centers for Disease Control and Prevention. (2018a). BRFSS Questionnaires. Retrieved from https://www.cdc.gov/brfss/questionnaires/index.htm

Centers for Disease Control and Prevention (2018b). Type 1 Diabetes. Retrieved from https://www.cdc.gov/diabetes/basics/type2.html

Centers for Disease Control and Prevention (2018c). Type 2 Diabetes. Retrieved from https://www.cdc.gov/diabetes/basics/type2.html

Centers for Disease Control and Prevention (2017a). About Diabetes. Retrieved from https://www.cdc.gov/diabetes/basics/diabetes.html

Centers for Disease Control and Prevention (2017b). More than 100 million Americans have diabetes or prediabetes. Retrieved from https://www.cdc.gov/media/releases/2017/p0718-diabetes-report.html

Chow, S. C., Shao, J., Wang, H., & Lokhnygina, Y. (2017). *Sample size calculations in clinical research*. New York: Basel.

D'Agostino, R.B., Chase, W., & Belanger, A. (1988). The appropriateness of some common procedures for testing the equality of two independent binomial populations. *The American Statistician 42*(3), 198-202.

Dai, S., Carroll, D. D., Watson, K. B., Paul, P., Carlson, S. A., & Fulton, J. E. (2015). Participation in types of physical activities among US adults—National Health and Nutrition Examination Survey 1999–2006. *Journal of Physical Activity and Health*, *12*(s1), S128-S140.

Department of Defense. (2011). Department of Defense Health Related Behaviors Survey of Active Duty Military Personnel. Retrieved from https://www.health.mil/Military-Health-Topics/Access-Cost-Quality-and-Safety/Health-Care-Program-Evaluation/Survey-of-Health-Related-Behaviors/2011-Health-Related-Behavior-Survey-Active-Duty

Farinha, J. B., Krause, M., Rodrigues-Krause, J., & Reischak-Oliveira, A. (2017). Exercise for type 1 diabetes mellitus management: General considerations and new directions. *Medical Hypotheses*, *104*, 147-153.

Fleiss, J. L., Levin, B., & Paik, M.C. 2003. *Statistical methods for rates and proportions* (3rd Ed.). Hoboken, NJ: John Wiley & Sons.

Flores, K. M. (2018). *Culturally sensitive diabetic group education* (Doctoral dissertation). Retrieved from SJSU ScholarWorks. https://scholarworks.sjsu.edu/cgi/viewcontent.cgi?article=1074&context=etd_doctoral

Gadsby, R. (2002). Epidemiology of diabetes. *Advanced Drug Delivery Reviews*, *54*(9), 1165-1172.

Hobbs, N., Godfrey, A., Lara, J., Errington, L., Meyer, T. D., Rochester, L., et al. (2013). Are behavioral interventions effective in increasing physical activity at 12 to 36 months in adults aged 55 to 70 years? A systematic review and meta-analysis. *BMC Medicine*, *11*(1), 75.

International Diabetes Federation. (2015). IDF Diabetes Atlas, 7th edition. Brussels, Belgium: International Diabetes Federation.

Kaminsky, L. A., & Dewey, D. (2014). The association between body mass index and physical activity, and body image, self esteem and social support in adolescents with type 1 diabetes. *Canadian Journal of Diabetes*, *38*(4), 244-249.

Knight, C. (2016). Type 1 diabetes and physical activity: An assessment of knowledge and needs in healthcare practitioners. *Journal of Diabetes Nursing*, *20*(8), 271-277.

Lascar, N., Kennedy, A., Hancock, B., Jenkins, D., Andrews, R. C., Greenfield, S., & Narendran, P. (2014). Attitudes and barriers to exercise in adults with type 1 diabetes (T1DM) and how best to address them: A qualitative study. *PLoS One*, *9*(9), e108019.

Machin, D., Campbell, M., Fayers, P., & Pinol, A. (1997). Sample size tables for clinical studies (2nd Ed.). Malden, MA: Blackwell Science.

Maahs, D. M., West, N. A., Lawrence, J. M., & Mayer-Davis, E. J. (2010). Epidemiology of type 1 diabetes. *Endocrinology and Metabolism Clinics*, *39*(3), 481-497.

Meadows, S. O., Engel, C. C., Collins, R. L., Bechman, R., Cefalu, M., Hawes-Dawson, J., et al. (2018). 2015 Department of Defense Health Related Behaviors Survey (HRBS). Retrieved from https://www.rand.org/pubs/research_reports/RR1695.html

Michigan Diabetes Research Center. (1998, December 18). Diabetes attitude survey. Retrieved from http://diabetesresearch.med.umich.edu/peripherals/profs/documents/svi/das3_new.pdf

Miller, T. A., & DiMatteo, M. R. (2013). Importance of family/social support and impact on adherence to diabetic therapy. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, *6*, 421-426.

Minges, K. E., Whittemore, R., & Grey, M. (2013). Overweight and obesity in youth with type 1 diabetes. *Annual Review of Nursing Research*, *31*, 47-69.

Norman, J. (2019). What is type 1 diabetes? Retrieved from https://www.endocrineweb.com/conditions/type-1-diabetes/type-1-diabetes

National Institute of Diabetes and Digestive and Kidney Diseases. (2017). Diabetes statistics. Retrieved from https://www.niddk.nih.gov/health-information/health-statistics/diabetes-statistics

Piette, J. D., & Kerr, E. A. (2006). The impact of comorbid chronic conditions on diabetes care. *Diabetes Care*, *29*(3), 725-731.

Polsky, S., & Ellis, S. L. (2015). Obesity, insulin resistance, and type 1 diabetes mellitus. *Current Opinion in Endocrinology, Diabetes and Obesity*, *22*(4), 277-282.

Pozzilli, P., & Buzzetti, R. (2007). A new expression of diabetes: double diabetes. *Trends in Endocrinology & Metabolism*, *18*(2), 52-57.

RPubs (2016). Games-Howell post-hoc test. Retrieved from https://rpubs.com/aaronsc32/games-howell-test

Ryan, P. (2009). Integrated theory of health behavior change: Background and intervention development. *Clinical Nurse Specialist CNS, 23*(3), 161-170.

Senter, C., Appelle, N., & Behera, S. K. (2013). Prescribing exercise for women. *Current Reviews in Musculoskeletal Medicine, 6*(2), 164-172.

Shields, C. A., Fowles, J. R., Dunbar, P., Barron, B., McQuaid, S., & Dillman, C. J. (2013). Increasing diabetes educators' confidence in physical activity and exercise counselling: The effectiveness of the "physical activity and exercise toolkit" training intervention. *Canadian Journal of Diabetes, 37*(6), 381-387.

Smyth, S., & Heron, A. (2006). Diabetes and obesity: The twin epidemics. *Nature Medicine, 12*(1), 75-80.

Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group. (2009). Sustained benefit of continuous glucose monitoring on A1C, glucose profiles, and hypoglycemia in adults with type 1 diabetes. *Diabetes Care, 32*(11), 2047-2049.

United States Department of Health & Human Services (2018). 2018 physical activity guidelines advisory committee scientific report. Retrieved October 8, 2019, from https://health.gov/paguidelines/secondedition/report/pdf/PAG_Advisory_Committee_Report.pdf

United States Department of Health & Human Services (2018b). Physical Activity Guidelines for Americans. Retrieved October 8, 2019, from https://www.hhs.gov/fitness/be-active/physical-activity-guidelines-for-americans/index.html

Van Belle, T. L., Coppieters, K. T., & Von Herrath, M. G. (2011). Type 1 diabetes: Etiology, immunology, and therapeutic strategies. *Physiological Reviews*, *91*(1), 79-118.

Whitfield, G. P., Carlson, S. A., Ussery, E. N., Fulton, J. E., Galuska, D. A., & Petersen, R. (2019). Trends in meeting physical activity guidelines among urban and rural dwelling adults—United States, 2008–2017. *Morbidity and Mortality Weekly Report*, *68*(23), 513.

Zhao, G., Ford, E. S., Li, C., & Mokdad, A. H. (2008). Compliance with physical activity recommendations in US adults with diabetes. *Diabetic Medicine*, *25*(2), 221-227.

Appendix A - Survey Questions

Diabetes Survey

Screening Form:

1. Are you between the ages of 18 and 64?
    a. Yes b. No
2. Are you able to understand and answer survey questions in English?
    a. Yes b. No
3. Do you have a physical or mental condition that prevents you from participating in physical activity or exercise?
    a. Yes b. No

Thank you for your participation in our research!

Study Description: The purpose of this research is to identify the different influences that affect physical activity and exercise behaviors by diabetes status. In addition to this, we will use your responses to different types and intensities of exercise in order to better characterize the types of exercise reported for each group. In the future, the cumulative collected data will be used in a thesis, submitted for conference presentation, and published in a peer-reviewed journal. We are not collecting information about your identity and your responses will not be linked to you personally. The information you provide will contribute to research we hope is valuable for the field of exercise behavior. The survey should take approximately 20-30 minutes to complete, you can leave the survey at any point, but your answers up to that point will be included in this research study.

PROJECT TITLE: Differences in exercise behaviors by diabetes status: a survey of exercise types, intensities, and influences

Please feel free to share this survey opportunity with those you know.

If you have any questions, comments, or concerns, please direct them to Cassandra Beattie, who can be reached at [email].

Participants who complete the survey will be eligible to win one of eight Amazon gift cards of up to a $75 value.

1. Do you agree to participate in this survey?
    a. Yes b. No
2. Are you male or female? Select one response.
    1. Male 2. Female
3. How old are you?
    Please type in your response. _____ (2 digits; 18–70)

4. Are you Spanish/Hispanic/Latino? Select one response.
    1. Yes, Mexican, Mexican-American, Chicano, Puerto Rican, Cuban, or other Spanish/ Hispanic/Latino
    2. No, not Spanish/Hispanic/Latino

5. What is your race? Please select ONE OR MORE responses that best characterize you.

    1. White 2. Black or African American 3. American Indian or Alaska Native 4. Asian (e.g., Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese) 5. Native Hawaiian or other Pacific Islander (e.g., Samoan, Guamanian, Chamorro) 6. Other _____

6. What is your height and weight?

    Please type your height: _____ feet ____ inches

    Please type in your weight in pounds _____

7. Have you been told by a health care provider that you have diabetes?

    a. Yes b. No

8. If yes, have you had your diabetes for at least 6 months or longer?

    b. Yes b. No

9. Are you Type 1 diabetic or Type 2 diabetic?

    c. Type 1 diabetic b. Type 2 diabetic.

TYPE 1 or TYPE 2

10. What was your A1C number when first diagnosed with diabetes?

    a. Not sure

    b. _____

11. What was your most recent A1C test number?

    a. Not sure

    b. _____

12. After your diabetes diagnosis, do you feel that your doctor properly informed you on how to take care of your blood sugar/diabetes when participating in different forms of physical activity, such as exercise (i.e. strength training, running)?

    1. Yes 2. No 3. Not sure

13. During the PAST 30 DAYS, how often did you do the following kinds of physical activity? Please select ONE response PER ROW.

A. Moderate Physical Activity— exertion that raises heart rate and breathing, but you should be able to carry on a conversation comfortably during the activity

    1. Not at all in the past 30 days
    2. <1 day per week
    3. 1 day per week
    4. 2 days per week
    5. 3 days per week
    6. 4 days per week

7. 5 days per week
8. 6 days per week
9. About every day

B. Vigorous Physical Activity— exertion that is high enough that you would find it difficult to carry on a conversation during the activity

1. Not at all in the past 30 days
2. <1 day per week
3. 1 day per week
4. 2 days per week
5. 3 days per week
6. 4 days per week
7. 5 days per week
8. 6 days per week
9. About every day

C. Strength Training— including using weights or resistance training to increase muscle strength

1. Not at all in the past 30 days
2. <1 day per week
3. 1 day per week
4. 2 days per week
5. 3 days per week
6. 4 days per week
7. 5 days per week
8. 6 days per week
9. About every day

14. During the PAST 30 DAYS, on the days you did the following, how many average minutes PER DAY did you typically do each? Please type in a response PER ROW.

A. Moderate Physical Activity— exertion that raises heart rate and breathing, but you should be able to carry on a conversation comfortably during the activity

1. _____ Minutes

B. Vigorous Physical Activity— exertion that is high enough that you would find it difficult to carry on a conversation during the activity

1. _____ Minutes

C. Strength Training— including using weights or resistance training to increase muscle strength

1. _____ Minutes

15. What types of physical activity/exercise do you do each week (e.g., walking)? Please type in your response below.

_____

16. Out of the forms of physical activity/exercise you listed, which do you most frequently participate in? Please type in your response below.

_____

17. How do you feel before exercise/physical activity? Please pick your answer from the checklist below.

a. active b. placid c. sleepy d. jittery e. energetic f. intense g. calm h. tired i. vigorous
j. at-rest k. drowsy l. fearful m. lively n. still o. wide awake p. clutched-up q. quiet
r. full-of-pep s. tense t. wakeful u. other _____

18. How do you feel after exercise/physical activity? Please pick your answer from the checklist below.

a. active b. placid c. sleepy d. jittery e. energetic f. intense g. calm h. tired i. vigorous
j. at-rest k. drowsy l. fearful m. lively n. still o. wide awake p. clutched-up q. quiet
r. full-of-pep s. tense t. wakeful u. other _____

19. What do you do to prepare to participate in physical activity/exercise (i.e. check blood sugar, take supplements, drink juice, other, etc.)? Please type in your response.

_____

20. What do you do after physical activity/exercise to take care of your diabetes? (i.e. check blood sugar, take supplements, drink juice, other, etc.) Please type in your response.

_____

21. Do you actively engage in goal setting for your health?

1. Yes 2. No

If yes, what are your current health related goals?

_____

22. How many days of physical activity did it take for you to see improvements in your blood glucose control? Please type in your response.

_____

a. How much did it improve? Please type in your response (i.e. changing from 110 to 90)

_____

23. How much physical activity per day does it take to improve your BG control? (i.e. improvements after an hour, two hours, or more).

a. Minutes per day _____

24. After stopping physical activity or exercise, how many days does it take before you see changes in your blood glucose control? Please type in your response.

_____

b. What change do you typically see? Please type in your response (i.e. changing from 90 to 110)

_____

25. What has happened to your blood glucose levels when participating in aerobic activity that you did or didn't like? Please type in your response.

Did like	Didn't like

26. What has happened to your blood glucose levels when participating in resistance training that you did or didn't like? Please type in your response.

Did like	Didn't like

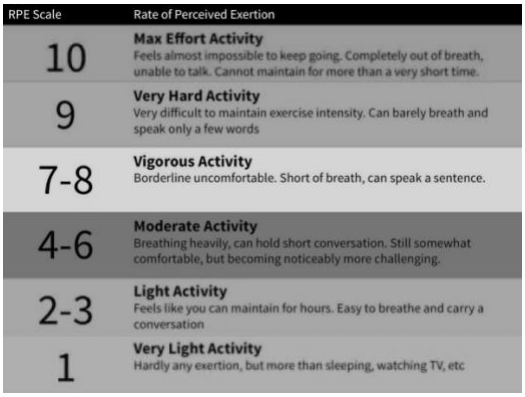
27. Which do you prefer more:

a. Resistance training
b. Aerobic training
c. Both equally
d. other _____

Please explain your preference for type of activity. Please type in your response.

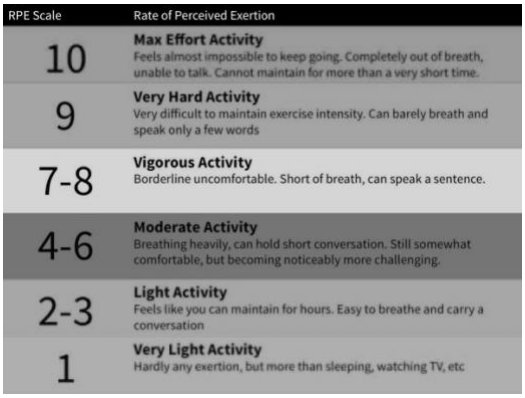
_____

28. Thinking of when you do aerobic activity, please rate your preferred intensity using the Rate of Perceived Exertion scale below by using the sliding bar.



1 ——●—— 10

29. Thinking of when you do resistance training, please rate your preferred intensity using the Rate of Perceived Exertion scale below by using the sliding bar.



1 ——●—— 10

30. What concerns do you have about participating in structured exercise programs? Please type in your response.

_____

31. What concerns do you have about participating in aerobic exercise? Please type in your response.

_____

32. What concerns do you have about participating in resistance training exercise? Please type in your response.

_____

33. Has anyone (parent, friend, teacher, coach etc.) told you not to participate in any type of physical activity or exercise?

1. Yes 2. No 3. Not sure

If yes, please type your responses below

Who:_____

Form of exercise: _____

34. What would you like to learn about exercise and physical activity in relation to your diabetes? Please type in your response.

_____

35. How often does your health care provider talk to you about exercise and physical activity?

1. Never
2. Once
3. Occasionally
4. Every other visit
5. Other _____

36. Did your health care provider recommend certain types of physical activity or exercise to you?

1. Yes 2. No

If yes, what kind? Please type in your response.

_____

How much activity (number of times per week or minutes per day) did they recommend? Please type in your response.

_____

Does your health care provider ever warn you to not participate in certain physical activity or exercise?

1. Yes 2. No

If yes, please specify what kind(s) below.

_____

37. Do you believe your health care provider lacks knowledge or expertise in physical activity or exercise for people with diabetes?

1. Yes 2. No 3. Not sure

38. Which of the following has your health care team (health care provider, nurse, dietician, or diabetes educator) advised you to do? **Please check all that apply.**

1. Follow a low-fat eating plan
2. Follow a complex carbohydrate diet
3. Reduce the number of calories you eat to lose weight
4. Eat lots of food high in dietary fiber
5. Eats lots (at least 5 servings per day) of fruits and vegetables
6. Eat very few sweets (for example: desserts, non-diet sodas, candy bars)
7. Other (specify): _____
8. I have not been given any advice about my diet by my health care team

39. Which of the following has your health care team (health care provider, nurse, dietician, or diabetes educator) advised you to do? **Please check all that apply.**

1. Get light-intensity exercise (such as walking) on a daily basis.
2. Complete 150+ minutes of moderate aerobic activity spread throughout the week
3. Complete 75+ minutes of vigorous aerobic activity spread throughout the week
4. Complete muscle strengthening exercises at least 2x a week on non-consecutive days
5. Fit exercise into your daily routine (for example, take stairs instead of elevators, park a block away and walk, etc.)
6. Engage in specific amount, type, duration and level of exercise.
7. Other (specify): _____
8. I have not been given any advice about exercise by my health care team

40. How satisfied are you with your supplied education on diabetes? Please check:

1. Not at all
2. Somewhat
3. Very

41. How satisfied are you with how you are managing your diabetes? Please check:

1. Not at all
2. Somewhat
3. Very

42. How confident are you in your ability to learn about diabetes and make lifestyle changes to improve your health? Please check:

1. Not at all
2. Somewhat
3. Very

43. How important to you is making changes to improve your diabetes care? (i.e. change in diet, exercise, etc.). Please check:

1. Not at all
2. Somewhat
3. Very

44. Who helps you manage your diabetes? (please check)

1. No one 2. Family 3. Co-workers 4. Healthcare Provider 5. Support Group 6. Other ___

45. How do you treat low blood sugar? (please check)

1. Nothing 2. Eat candy 3. Take sugar 4. Eat food 5. Drink juice 6. Other _____

46. Can you tell when your blood sugar is too high?

1. Yes 2. No

47. What do you do when your blood sugar is too high? (please check)

1. Nothing 2. Drink water 3. Drink broth 4. Take insulin 5. Other _____

48. Have you ever been in uncomfortable social situations related to your diabetes care (e.g., people telling you what to eat)?

1. Yes. 2. No

49. Have you ever felt dissatisfied with your diabetes health care provider and your interactions with him/her?

1. Yes 2. No

50. Do you feel your family and friends are supportive of your diabetes management efforts (i.e. make you feel confident in what you do, help you, etc.)?

1. Yes 2. No

Thank you for your participation in this survey! The purpose of this research is to identify the different influences that affect physical activity and exercise behaviors by diabetes status. In addition to this, we will use your responses to different types and intensities of exercise in order to better characterize the types of exercise reported for each group. In the future, the cumulative collected data will be used in a thesis, submitted for conference presentation, and published in a peer-reviewed journal. While your responses will not be linked to you personally, your participation in this research is valuable in helping to collect information to contribute to research we hope is valuable for the field of exercise behavior.

Please feel free to share this survey opportunity with those you know.

If you have any questions, comments, or concerns, please direct them to Cassandra Beattie. She can be contacted at [email].

If you would like to be entered in the drawing for one of eight Amazon gift cards up to a $75 The **next** page will direct you to the participant draw where you may enter your email address to win. We will only contact those who have won.

Non-Diabetic Survey

Screening Form:

4. Are you between the ages of 18 and 64?
    a. Yes b. No
5. Are you able to understand and answer survey questions in English?
    a. Yes b. No
6. Do you have a physical or mental condition that prevents you from participating in physical activity or exercise?
    a. Yes b. No

Thank you for your participation in our research!

Study Description: The purpose of this research is to identify the different influences that affect physical activity and exercise behaviors by diabetes status (Type 1, Type 2, or non-diabetics). In addition to this, we will use your responses to different types and intensities of exercise in order to better characterize the types of exercise reported for each group. In the future, the cumulative collected data will be used in a thesis, submitted for conference presentation, and published in a peer-reviewed journal. We are not collecting information about your identity and your responses will not be linked to you personally. The information you provide will contribute to research we hope is valuable for the field of exercise behavior. The survey should take approximately 20-30 minutes to complete, you can leave the survey at any point, but your answers up to that point will be included in this research study.

PROJECT TITLE: Differences in exercise behaviors by diabetes status: a survey of exercise types, intensities, and influences

Please feel free to share this survey opportunity with those you know.

If you have any questions, comments, or concerns, please direct them to Cassandra Beattie, who can be reached at [email].

Participants who complete the survey will be eligible to win one of eight Amazon gift cards of up to a $75 value.

1. Do you agree to participate in this survey?
    b. Yes b. No
2. Are you male or female? Select one response.
    1. Male 2. Female
3. How old are you?
    Please type in your response. _____ (2 digits; 18–70)
4. Are you Spanish/Hispanic/Latino? Select one response.

3. Yes, Mexican, Mexican-American, Chicano, Puerto Rican, Cuban, or other Spanish/ Hispanic/Latino
4. No, not Spanish/Hispanic/Latino

5. What is your race? Please select ONE OR MORE responses that best characterize you.

1. White 2. Black or African American 3. American Indian or Alaska Native 4. Asian (e.g., Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese) 5. Native Hawaiian or other Pacific Islander (e.g., Samoan, Guamanian, Chamorro) 6. Other _____

6. What is your height and weight?

Please type your height: _____ feet ____ inches

Please type in your weight in pounds _____

7. Have you been told by a health care provider that you have diabetes?

d. Yes b. No

8. If yes, have you had your diabetes for at least 6 months or longer?

e. Yes b. No

9. Are you Type 1 diabetic or Type 2 diabetic?

f. Type 1 diabetic b. Type 2 diabetic.

NON-DIABETICS

10. Have you ever been diagnosed with Prediabetes?

1. Yes 2. No

11. Identify the diabetes symptoms that you are knowledgeable of.

a. increased thirst **b.** hair loss **c.** extreme hunger **d.** unexplained weight-loss **e.** loss of memory **f.** frequent urination **g.** migraines **h.** fatigue **i.** anxiety **j.** slow healing wounds **k.** blurred vision **l.** stomach pain **m.** gradually putting on weight **n.** frequent headaches **o.** skin infections **p**. change of skin color **q.** mood swings

12. Have you had your blood glucose levels tested?

1. Yes 2. No 3. Unsure

If yes, please type in your results: _____ mg/dl

13. During the PAST 30 DAYS, how often did you do the following kinds of physical activity? Please select ONE response PER ROW.

A. Moderate Physical Activity— exertion that raises heart rate and breathing, but you should be able to carry on a conversation comfortably during the activity.

10. Not at all in the past 30 days
11. <1 day per week
12. 1 day per week
13. 2 days per week
14. 3 days per week
15. 4 days per week
16. 5 days per week
17. 6 days per week

18. About every day

B. Vigorous Physical Activity— exertion that is high enough that you would find it difficult to carry on a conversation during the activity

1. Not at all in the past 30 days
2. <1 day per week
3. 1 day per week
4. 2 days per week
5. 3 days per week
6. 4 days per week
7. 5 days per week
8. 6 days per week
9. About every day

C. Strength Training— including using weights or resistance training to increase muscle strength

1. Not at all in the past 30 days
2. <1 day per week
3. 1 day per week
4. 2 days per week
5. 3 days per week
6. 4 days per week
7. 5 days per week
8. 6 days per week
9. About every day

14. During the PAST 30 DAYS, on the days you did the following, how long PER DAY did you typically do each? Please type in a response PER ROW.

A. Moderate Physical Activity— exertion that raises heart rate and breathing, but you should be able to carry on a conversation comfortably during the activity

1. _____ Minutes

B. Vigorous Physical Activity— exertion that is high enough that you would find it difficult to carry on a conversation during the activity

1. _____ Minutes

C. Strength Training— including using weights or resistance training to increase muscle strength

1. _____ Minutes

15. What types of physical activity/exercise do you complete each week (e.g., walking)? Please type in your response below.

_____

16. Out of the forms of physical activity/exercise you listed, which do you ~~most frequently~~ participate in? Please type in your response below.

_____

17. How do you feel before exercise/physical activity? Please pick your answer from the checklist below.

a. active b. placid c. sleepy d. jittery e. energetic f. intense g. calm h. tired i. vigorous
j. at-rest k. drowsy l. fearful m. lively n. still o. wide awake p. clutched-up q. quiet
r. full-of-pep s. tense t. wakeful u. other _____

18. How do you feel after exercise/physical activity? Please pick your answer from the checklist below.

a. active b. placid c. sleepy d. jittery e. energetic f. intense g. calm h. tired i. vigorous
j. at-rest k. drowsy l. fearful m. lively n. still o. wide awake p. clutched-up q. quiet
r. full-of-pep s. tense t. wakeful u. other _____

19. What do you do to prepare to participate in physical activity/exercise (i.e. take supplements, drink water, other, etc.)? Please type in your response.

_____

20. What do you do after physical activity/exercise to take care of yourself? (i.e. take supplements, drink water, other, etc.) Please type in your response.

_____

21. Do you actively engage in goal setting for your health?

1. Yes, 2. No

If yes, what are your current health related goals?

_____

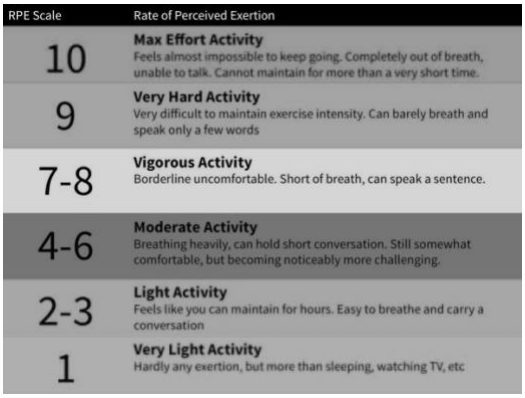
22. Which do you prefer more?

a. Resistance training
b. Aerobic training
c. Both equally
d. other _____

Please explain your preference for type of activity. Please type in your response.

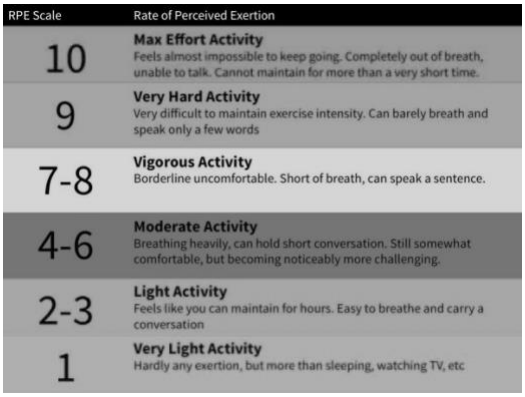
_____

23. Thinking of when you do aerobic activity, please rate your preferred intensity using the Rating of Perceived Exertion scale below by using the sliding bar.



1 ——●—— 10

24. Thinking of when you do resistance training, please rate your preferred intensity using the Rating of Perceived Exertion scale below by using the sliding bar.



1 ——●—— 10

25. What has happened to your body/energy levels when participating in aerobic activity that you did or didn't like? Please type in your response.

Did like	Didn't like

26. What has happened to your body/energy levels when participating in resistance training that you did or didn't like? Please type in your response.

Did like	Didn't like

27. What concerns do you have about participating in physical activity/exercise in general? Please type in your response.

_____

28. What concerns do you have about participating in aerobic activity? Please type in your response.

_____

29. What concerns do you have about participating in resistance training? Please type in your response.

_____

30. Has anyone (parent, friend, etc.) told you not to participate in any type of physical activity or exercise?

2. Yes 2. No 3. Not sure

If yes, please type your responses below

Who:_____

Form of exercise: _____

31. What would you like to learn about exercise and physical activity in relation to your health? Please type in your response.

_____

32. When visiting your health care provider, how often have they talked to you about exercise and/or physical activity?

1. Never
2. Once
3. Occasionally
4. Every other visit
5. Other _____

33. Did your health care provider recommend certain types of physical activity?

1. Yes 2. No

If yes, what kind? Please type in your response.

_____

How much activity (number of times per week or minutes per day) did they recommend? Please type in your response.

_____

Did they warn you to not participate in certain physical activity or exercise?

2. Yes 2. No

If yes, please explain why. Please type in your response.

_____

34. Do you believe your health care provider has made efforts to explain the importance of physical activity and exercise?

1. Yes 2. No 3. Not sure

35. Which of the following has your health care team (health care provider, nurse, dietician, or other health professional) advised you to do? **Please check all that apply.**

9. Follow a low-fat eating plan
10. Follow a complex carbohydrate diet
11. Reduce the number of calories you eat to lose weight

12. Eat a lot of food high in dietary fiber
13. Eats a lot (at least 5 servings per day) of fruits and vegetables
14. Eat very few sweets (for example: desserts, non-diet sodas, candy bars)
15. Other (specify): _____
16. I have not been given any advice about my diet by my health care team

36. Which of the following has your health care team (doctor, nurse, dietician, or other health care professional) advised you to do? **Please check all that apply.**

9. Get light-intensity exercise (such as walking) on a daily basis.
10. Complete 150+ minutes of moderate aerobic activity spread throughout the week
11. Complete 75+ minutes of vigorous aerobic activity spread throughout the week
12. Complete muscle strengthening exercises at least 2x a week on non-consecutive days
13. Fit exercise into your daily routine (for example, take stairs instead of elevators, park a block away and walk, etc.)
14. Engage in specific amount, type, duration and level of exercise.
15. Other (specify): _____
16. I have not been given any advice about exercise by my health care team

Thank you for your participation in this survey! The purpose of this research is to identify the different influences that affect physical activity and exercise behaviors by diabetes status. In addition to this, we will use your responses to different types and intensities of exercise in order to better characterize the types of exercise reported for each group. In the future, the cumulative collected data will be used in a thesis, submitted for conference presentation, and published in a peer-reviewed journal. While your responses will not be linked to you personally, your participation in this research is valuable in helping to collect information to contribute to research we hope is valuable for the field of exercise behavior.

Please feel free to share this survey opportunity with those you know.

If you have any questions, comments, or concerns, please direct them to Cassandra Beattie. She can be contacted at [email].

If you would like to be entered in the drawing for one of eight Amazon gift cards up to a $75 The **next** page will direct you to the participant draw where you may enter your email address to win. We will only contact those who have won.