Analyzing the Association between Impulsivity, Diabetes, Eating Behavior, Physical Activity Behavior, and Medication Adherence

by

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A thesis submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements for the Degree of
Master of Science

Auburn, Alabama
December 12, 2015

Keywords: impulsivity, delay discounting, eating behavior, physical activity behavior, medication adherence

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Abstract

Background: Impulsivity has been shown to be associated with many unhealthy lifestyle factors: obesity, unhealthy eating, and decreased physical activity, all of which are associated with having diabetes. However, no study has assessed the direct association between impulsivity and diabetes.

Objectives: The objectives of this study are to (a) analyze the association between diagnosis of diabetes and impulsivity, and examine Body Mass Index (BMI) as a mediator; (b) analyze the association between impulsivity and eating and physical activity behaviors; and (c) analyze the association between impulsivity and medication adherence.

Method: Cross-sectional online survey

Results: Increased level of impulsivity was associated with increased BMI and less desirable eating, physical activity, and medication adherence behaviors, but was not associated with diagnosis of diabetes.

Conclusions: These findings underscore the importance of incorporating methods to mitigate the influence of impulsivity on certain health behaviors.

Acknowledgments

During the preparation of this thesis, many people contributed to this research and have given me suggestions, advice, and supports. I would never have been able to complete this Master's thesis without them: my advisor, committee members, family and friends. I am extremely grateful to each and every one of them.

First and foremost I owe my sincere thanks to my advisor, Dr. Kimberly Garza, for her patience, encouragement, guidance, feedback and advice throughout my thesis research. She was never too busy to help and support, and her advice has made my thesis a rewarding experience. She made my time in Graduate School very memorable.

Second, I would like to express my appreciation to my thesis committee: Dr. Salisa Westrick, Dr. Kimberly Braxton Lloyd, and Dr. Ash Abebe for their support and guidance as well. As I was moving from an idea to a complete study, they all provided me with valuable comments, which were insight from their respective area.

Third, I would like to extend my gratitude to Dr. Richard A. Hansen, Dr. Donald E. Morisky, and Dr. Marilyn Townsend who allowed me to use their questionnaire in my research.

Fourth, I would like to thank my family and friends for their help, encouragement and support in all my pursuits. Thanks are also due to all of my colleagues at Auburn, especially Yasser Alatawi and Justin Owensby who helped me with this work.

Finally, I have to sincerely thank Auburn University for providing me with an excellent education. The time I spent here will be cherished for many years to come.

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List of Abbreviations

SSR	Smaller sooner reward
LLR	Larger later reward
AUC	Area under the delay discounting curve
BMI	Body mass index
AIC	Akaike information criterion

Chapter 1. Introduction

The Burden of Diabetes

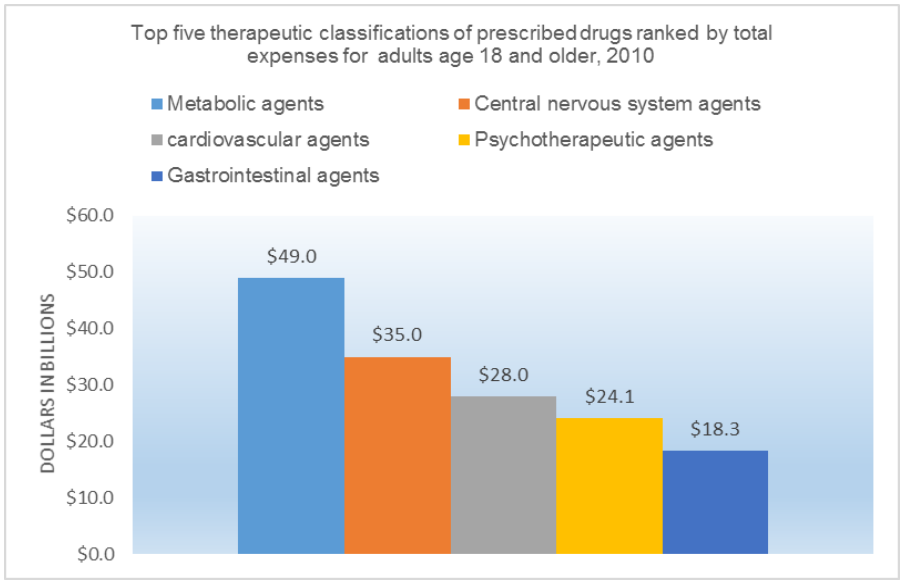
Diabetes is a common disease in many countries around the world. The prevalence of diabetes is increasing, likely due to population growth, aging of the population, and increasingly unhealthy lifestyle, which leads to poor diet, reduced physical activity, and obesity, factors that increase the risk of developing diabetes. According to the International Diabetes Federation (IDF), an estimated 382 million (8.3%) of adults in 2013 around the world had diabetes (1). The majority of them were between 40 and 59 years old, and 80% of them live in low- and middle-income countries, such as China, India, and Brazil. The report has estimated the global population with diabetes will increase to 592 million people by 2035 (1). Diabetes is one of the major causes of death in most high-income countries (2). The burden of diabetes results in $548 billion in healthcare expenditures or 11% of the global health expenditure (1).

In the United States, the data from the National Diabetics Surveillance System show that the number of diabetic patients between 18 -79 years old has increased threefold from 1980 through 2010 (3). According to the Center for Disease Control and Prevention (CDC), approximately 29.1 million people or 9.3% of people in the United States have diabetes, and the total cost of diabetes in the U.S in 2012 was around $245 billion: $176 in direct medical costs, and $69 million in indirect costs (4). Furthermore, in 2012 approximately 1.7 million of the United States adults aged 20 years or older were diagnosed with diabetes, and approximately 200,000 of the United States population who are younger than 20 years old were diagnosed with diabetes (4).

Obesity as a Major Global Health Issue

Since 2000 the World Health Organization (WHO) has recognized obesity as a global health problem (5). According to the WHO, obesity is defined as abnormal or excessive fat accumulation which may impair health. Overweight and obesity is the fifth highest cause of death worldwide (6). The WHO in 2008 estimated 35% of adults aged 20 and over all around the world were overweight (7). In the United States, the obesity rates have more than doubled in adults from 1960 through 2008, and the prevalence of being overweight or obese in the United States in 2009 was 68.8% (8, 9). Obesity costs the United States $118 billion annually or approximately 12% of the United States health care expenditure, which was more than double the $47 billion of health care expenditure associated with smoking (10). According to the American College of Endocrinology and the American Association of Clinical Endocrinology, obesity or excess weight is one of the risk factors for diabetes (11). A systematic literature review on the prevalence of hypertension and obesity in patients with type 2 diabetes showed over 30% of patients with type 2 diabetes were overweight or obese (12). Moreover, obesity increases the risk of many health problems: hypertension, cardiovascular disease, and diabetes (13-16). These diseases were the leading causes of death in the United States in 2010 and they were associated with high medical expenditures as seen in Figure 1 (17, 18). Seven of the top 10 causes of death were chronic diseases. Together, heart disease and cancer accounted for approximately 48% of all deaths (19). To prevent being overweight or obese, the WHO recommended limiting the consumption of fats and sugar, consuming healthy foods by increasing fruit and vegetable consumption, and engaging in regular physical activity for at least 150 minutes per week for adults (7).

Figure 1: Top five theraputic classifications of precribed drugs ranked by total expenses for adults age 18 and older 2010



* Adapted from Center for financing, access, and cost trends, AHRQ, Household and Pharmacy Components of the Medicaid Expenditure Panel Survey 2010

The Importance of Medication Adherence

Medication non-adherence is another critical health care problem especially in patients with chronic diseases (20). In spite of this, medication non-adherence is preventable. Approximately 31-71% are non-adherent to medications given four times per day, which results in an estimated $105 billion in preventable expenditure annually (21, 22). Despite the fact that the medication adherence rate in clinical trials can be notably high because the attention of staff to patients, clinical trials report average adherence rates of chronic disease patients were only 34 – 97% (21, 23). Approximately 80% of adults in the United States are taking at least one medication and nearly 30% are taking five or more medications (24). According to Pittman et al. in a study of adherence to statins, the primary drug class used to decrease low-density lipoprotein cholesterol (LDL), they found nearly one-third of their patients were not adhering to statins in

the baseline year and non-adherence was associated with $400 to $900 per patient (25). Suppose extrapolating this finding to around 24 million patients who receive statins in the United States. Increasing medication adherence can save more than $3 billion annually in healthcare expenditure (25). In diabetes, systematic reviews showed that the prevalence of medication adherence ranged from 36.0 to 93.1% (26, 27). Studies have shown that medication adherence plays an important role to improve treatment outcomes in many diseases, such as heart disease, hypercholesterolemia, and hypertension (28-30).

Many chronic diseases are the long-term results of unhealthy behaviors (e.g., poor diet, sedentary lifestyle, and non-adherence to prescribed medications), which often do not appear until far into the future. Patients often fail to consider future consequences, placing a higher value on immediate gains. In turn, behaviors to prevent long-term complications of disease are often not adopted.

Impulsivity and Its Association with Health Behaviors

Impulsivity has been defined as an action without adequate thought or regard to the consequences of such action, which reflects a myopic view, and often results in undesirable outcomes (31). Impulsive people have a tendency to choose immediate rewards over delayed rewards and to minimize the subjective value of long-term rewards. In the field of behavioral economics, delay discounting is a concept that is used to characterize an individual's level of impulsivity. This concept refers to the idea that an individual will devalue the future to varying degrees, depending on how far in the future rewards are received (32). From the health perspective, this may explain why many unhealthy behaviors are associated with high levels of impulsivity (e.g. drug use, alcohol abuse, cigarette smoking, obesity, diet, physical activity, and diabetes) (33-40). People with high level of impulsivity may have a tendency to choose more

immediate rewards (such as palatable foods or sedentary activities) over long-term avoidance of costly consequences (obesity and resulting chronic disease). This might explain an increased risk of developing diseases such as diabetes, whose negative outcomes often do not reveal themselves until far into the future. Further, previous studies showed that level of impulsivity is positively correlated with Body Mass Index (BMI) (41). BMI, an index of weight in kilograms divided by the square of height in meters (kg/m^2), is a measurement for categorizing obesity (42).

The overall goal of the study is to analyze the association between the level of impulsivity with diagnosis of diabetes, eating behavior, physical activity behavior, and medication adherence in order to inform behavioral interventions that lessen the impact of impulsivity on behaviors to prevent and treat diabetes.

Overview of the study design and specific aims

A cross-sectional survey was employed to address the research questions and test the following hypotheses. The target population in this study was Auburn University (AU) employees and dependents who participated in the AU Healthy Tigers program, administered by the Auburn University Pharmaceutical Care Center (AUPCC). All eligible AU employees and dependents got an invitation email. The invitation email included general information about the study, objective of the study, and a link to the online survey. In the online survey, participants completed a questionnaire, which includes demographics, general health information, level of impulsivity, eating behavior, and physical activity behavior. Participants who reported taking one or more oral medications for diabetes completed two additional instruments regarding medication adherence.

This study had three purposes. The first purpose was to measure and analyze the association between diagnosis of diabetes and level of impulsivity and examine BMI as a

mediator between these two variables. The second purpose was to measure and analyze the association between level of impulsivity and eating behavior and level of impulsivity and physical activity behavior. And the last purpose was to measure and analyze the association between level of impulsivity and medication adherence in patients who were treated pharmacologically for diabetes.

This study used a questionnaire that contains five instruments to measure the level of impulsivity, eating behavior, physical activity behavior, and medication adherence: a delay discounting task (40), the Food Behavior Checklist (FBC) (43), the Global Physical Activity Questionnaire (GPAQ) (44) , the Morisky Medication Adherence Scale (MMAS) and the Medometer (45-48).

To determine the level of impulsivity, this study employed a commonly used delay discounting task that asked participants to make a choice between hypothetical high-value monetary rewards to be received after a specified delay versus hypothetical low-value monetary rewards without delay. Further details of this structure and interpretation of the task are included in Chapter 3.

To determine eating behaviors, this study used the Food Behavior Checklist (FBC), a self-rating scale to measure fruit, vegetable, drink, and fat consumption (43). To determine physical activity behaviors, this study used the Global Physical Activity Questionnaire (GPAQ), which was a self-administered questionnaire of physical activity in three domains: activity at work, travel to and from places, and recreational activities (44). To determine medication adherence, we utilized two medication adherence instruments; the MMAS and the Medometer (45-48). Participants who reported a diagnosis of diabetes and who were currently receiving one or more medications for diabetes completed these medication adherence instruments.

Additionally, other factors such as self-reported height and weight, sex, age, education level, income, race, and ethnicity were examined to determine any association with the level of impulsivity. Participants completed the questionnaire via an online survey.

Specific Aim 1

Determine the association between level of impulsivity and diabetes, and test if BMI serves as a mediator.

We compared the level of impulsivity in patients with a self-reported diagnosis of diabetes to those who did not report a diagnosis of diabetes. BMI was tested as a mediator of this association.

Specific Aim 2

Determine the association between level of impulsivity and eating behaviors and the level of impulsivity and physical activity behaviors in adults.

We tested the association between level of impulsivity and eating behaviors and level of impulsivity and physical activity behavior. The level of impulsivity was tested as an independent variable of this association and eating behaviors and physical activity behavior were tested as dependent variables.

Specific Aim 3

Determine the association between level of impulsivity and medication adherence in adults with diabetes.

We evaluated the association between the level of impulsivity and medication adherence. The level of impulsivity was tested as the independent variable of this association while, medication adherence was tested as the dependent variable of this association.

Study Significance

This study has potential significance contributing to three areas. First, this study determined the association between the level of impulsivity and diabetes among adults based on the concept of delay discounting. As a consequence, the plan is to understand the association between BMI, diabetes, and impulsivity. Then, utilizing this result, we may develop an intervention for health behavior modification to help people who have a high level of impulsivity with a diagnosis of diabetes to achieve the goal of treatment.

Secondly, this study analyzed the association between level of impulsivity, eating behaviors, physical activity behaviors, and medication adherence in adults with diabetes. Identifying the association between the level of impulsivity and these behaviors will help health care providers assist people with diabetes to modify their behaviors for controlling their blood glucose through targeted interventions that lessen the effect of impulsivity on these behaviors. Carefully structured interventions that help patients overcome impulsivity may be effective in a subgroup of patients with high levels of impulsivity without restricting the freedom of choice in individuals who are less impulsive. This concept is often referred to as asymmetric paternalism (49).

Lastly, because the participants to be recruited are mainly Auburn University employees and their dependents, findings can be used by Auburn University. The results of this study characterize the association between obesity, diagnosis of diabetes, and behaviors for prevention and treatment of diabetes. This will in turn inform targeted behavioral interventions to improve diet, physical activity, and medication adherence in patients with diabetes. Further, the knowledge of this project can help us identify individuals who might be at risk for developing diabetes, help people modify their behaviors, and help people with diabetes achieve the goal of

diabetes treatment: controlling blood glucose. Ultimately, this may help individuals, with or without diabetes, to have a better quality of life.

Chapter 2. Literature Review

Chapter 1 provides a summary of the background and research aims. This research seeks to examine the relationship among various concepts including diabetes, obesity, diet, physical activity, medication adherence, and impulsivity. In this Chapter, a more in-depth background is provided on each of the above concepts.

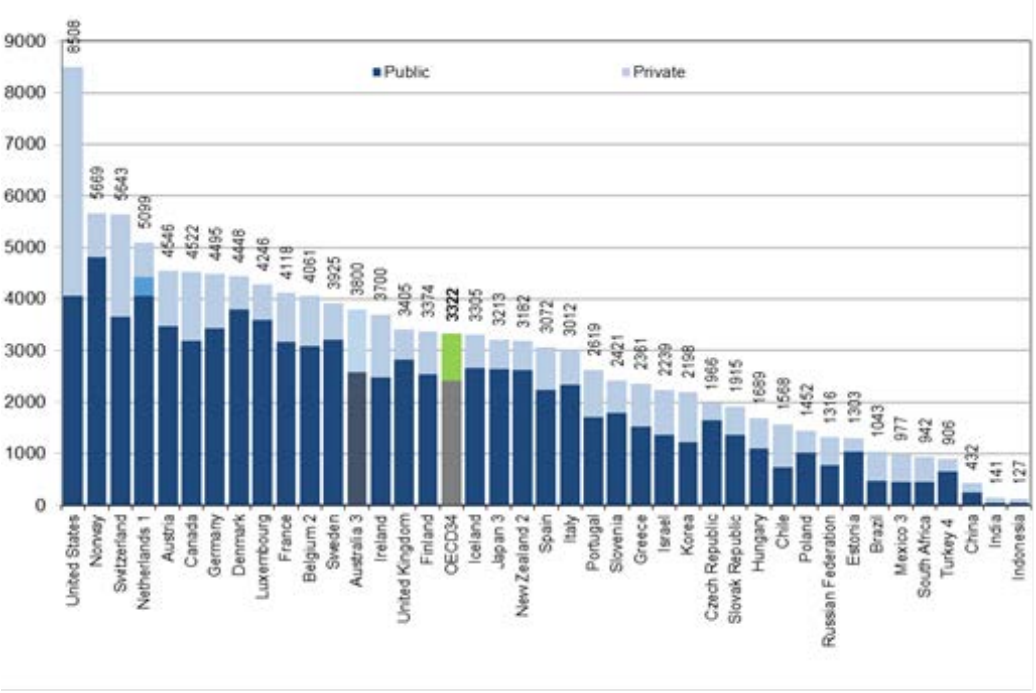
This chapter consists of five parts. The first part is the background of health care problems, which will discuss the burden of healthcare and move to the specific problems in health care. The second part describes the burden of diabetes. Next, the background of obesity and medication non-adherence will be presented. These four parts will describe the problems in three aspects: the worldwide aspect, the United States aspect, and the economic impact. The chapter will end with the concepts of impulsivity and delay discounting, in which some background information and studies will be discussed.

The Burden of Health Care

Countries around the world are facing many health care problems including the lack of access to health care and high mortality from non-communicable diseases, such as cardiovascular diseases, cancer, and diabetes. These issues involve multiple stakeholders, such as government organizations (policy makers and the Centers for Disease Control and Prevention [CDC]), private organizations (pharmaceutical companies and health insurance companies), academic organizations (medical schools, pharmacy schools, and public health schools), healthcare providers and healthcare services (hospitals and drug stores), and other organizations

that contribute to health and assure quality and accessibility of healthcare services. According to Robert Fogel, a Nobel Prize winner in Economics, and the World Health Organization (WHO), health has played an important role in economic growth for more than a century in developed countries (50). Rising healthcare expenditure is a problem in many countries like France, Germany, Norway and the United States (Figure 2) (51). All of these countries have health care expenditures higher than the average health care expenditure of the Organization for Economic Co-operation and Development (OECD) countries. Especially in the United States, rising healthcare expenditure is an important component of the American health policy agenda. The estimated healthcare expenditure of the United States in 2013 was $2.9 trillion or $9,255 per capita and this expenditure accounted for 17.4% of the nation's Gross Domestic Product (52).

Figure 2. Health expenditure per capita in various countries around the world, 2011 (or nearest year)



From Health at a Glance 2013: OECD Indicators

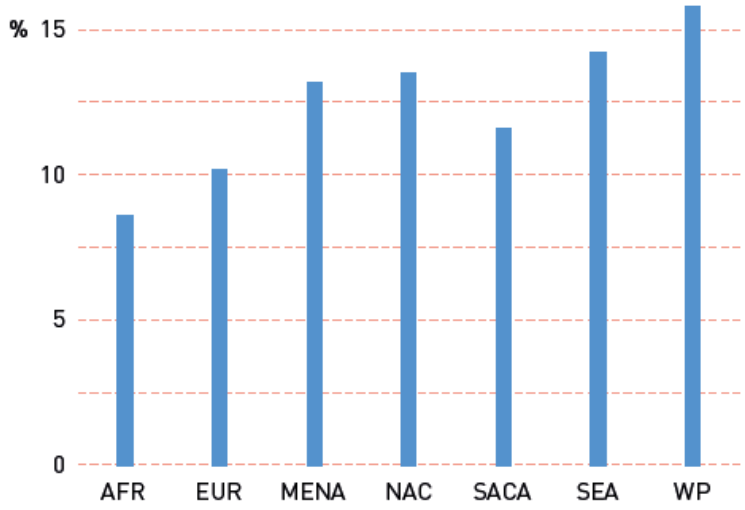
The Burden of Diabetes

According to the WHO definition, diabetes is a chronic disease that occurs when the pancreas does not produce enough insulin (type 1 diabetes) or when the pancreas produces enough insulin but the body cannot use it effectively (insulin resistance or type 2 diabetes), (53). Insulin is a hormone produced by the pancreas that allows the body to use sugar in food for energy or to store for the future. Moreover, after the body has insulin resistance for several years, it will cause the pancreas to produce less insulin. Hyperglycemia or high blood sugar level is a common situation that happens when the body has low insulin or the body cannot use insulin properly. Both types of diabetes require close collaboration between patients and health care providers in order to prevent dangerous complications such as retinal disease, kidney disease, and nerve damage.

Diabetes is a common disease in many countries around the world, and the prevalence of diabetes is increasing, likely due to population growth, aging of the population, and increasingly unhealthy lifestyle, which leads to poor diet, reduced physical activity, and obesity, factors that increase the risk of developing diabetes. It is undoubtedly one of the most challenging health problems in the 21st century. According to the International Diabetes Federation (IDF), an estimated 382 million (8.3%) of adults in 2013 around the world have diabetes, approximately 46% of whom are undiagnosed (1). The majority of them are aged between 40 and 59 years old, and 80% of them live in low- and middle-income countries, such as China, India, and Brazil. Nearly 200 million individuals with diabetes live in Western Pacific and South-East Asia region while, approximately 98.4 million live in China. Further, diabetes is one of the major causes of death in most high-income countries (2). IDF reported that the estimated global prevalence of diabetes will increase to 592 million by 2035 and an estimated 5.1 million people will die from

diabetes. That translates to a death every six seconds. Around 30% of deaths come from the Western Pacific and South-East Asia region as shown in the Figure 3. An additional 21 million women will have hyperglycemia in pregnancy. The burden of diabetes translates to $548 billion in health expenditure or 11% of the world of health expenditure (1).

Figure 3. Death attributable to diabetes as a percentage of all deaths (20-79 years) by IDF Region, 2013



From International Diabetes Federation. IDF Diabetes Atlas. 2015
AFR= Africa, EUR= Europe, MENA= Middle East and North Africa, NAC= North America and Caribbean, SACA= South and Central America, SEA= South-East Asia, WP= West Pacific

In the United States, data from the National Diabetics Surveillance System show that the number of patients with diabetes aged between 18 -79 years old has increased threefold from 1980 through 2010 (3). According to the Center for Disease Control and Prevention (CDC), approximately 29.1 million people or 9.3% of the people in the United States have diabetes (21.0 million diagnosed and 8.1 million undiagnosed)(4). When classifying people with diabetes aged 20 years or older by race/ethnicity, approximately 15% of American Indian and Alaska Native adults were diagnosed with diabetes, while only 7% of non-Hispanic whites were diagnosed with diabetes (4). In the United States, the total cost of diabetes was around $245 billion: $176 is

direct medical costs, and $69 million is indirect costs in 2012 (54). Approximately 1.7 million U.S. adults aged 20 years or older are newly diagnosed cases of diabetes, and approximately 200,000 of the United States population who are younger than 20 years old have a diagnosis of diabetes (4). Further, some of the people diagnosed with diabetes have co-existing conditions, such as high blood pressure, high LDL cholesterol, heart disease, retinal disease, and kidney disease. Among adults aged 18 years or older with a diagnosis of diabetes, 71% of them had blood pressure ≥ 140/90 millimeter of mercury or were prescribed medication to control their blood pressure, and 49,677 people started kidney failure treatment due to diabetes in 2011.

Obesity as a Major Global Health Issue

In June of 1997, the WHO Consultation on Obesity met in Geneva. This consultation consisted of more than 100 experts worldwide (5). The aim of the meeting was to review the epidemiology of obesity, and formulate recommendations for improving the management and prevention of obesity. This consultation's report, published in 2000, showed that the prevalence of overweight and obesity was increasing worldwide as a problem in both developed and developing countries. According to the WHO, obesity is defined as abnormal or excessive fat accumulation which may impair health. Body Mass Index (BMI), an index of weight in kilograms divided by the square of height in meters (kg/m^2), is a measurement for categorizing obesity (42). BMI value can be classified into four different groups. A person who has a BMI lower than 18.50 is considered as underweight. BMI between 18.50 and 24.99 is considered as normal weight. BMI between 25 and 29.9 is considered as overweight. And BMI of 30 or more is considered as obese (55). Further, an obese person can be classified as obese class I, II, or III. Obese class I corresponds to a BMI between 30 and 34.99. Obese class II corresponds to a BMI between 35.00 and 39.99, and obese class III corresponds to a BMI of 40 or more (55).

According to the WHO report on the Global Health risk, the five leading causes of death worldwide were high blood pressure, smoking, diabetes, physical inactivity, and overweight and obesity (6). Moreover, being overweight or obese accounted for 2.4% of disability-adjusted life years worldwide or 6.5% of disability-adjusted life years in high income countries in 2004. The WHO factsheet, updated in August 2014, estimated 35% of adults, more than 1.4 billion people aged 20 or over, were overweight worldwide. Of those, approximately 500 million were obese, accounting for 11% in 2008 (7). According to the data from the National Health and Nutrition Examination Survey (NHANES), the 2007-2008 NHANES showed that approximately 34.2% of the United States adults aged 20 years and over were overweight as shown in Table 1 (8). Furthermore, the data show that the obesity rates of adults aged 20-74 years have increased by more than double since 1960 through 2008 as shown in Figure 4 (8). The American College of Endocrinology and the American Association of Clinical Enodcrinology determine being overweight or obese as one of the risk factors for development of diabetes.

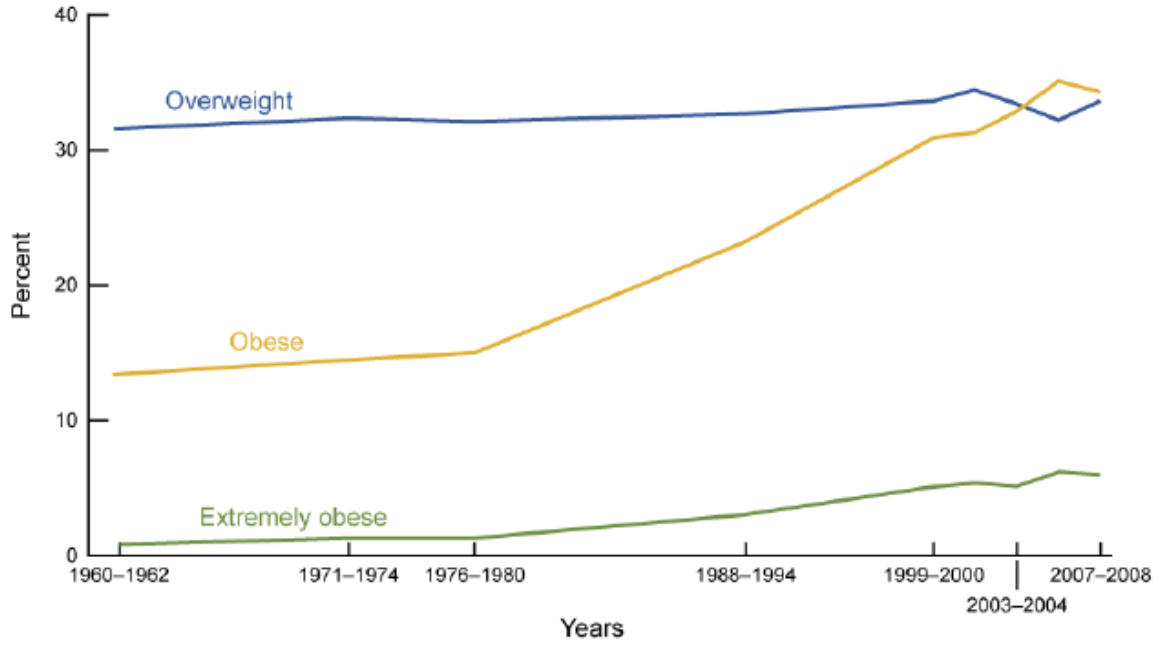
Table 1. Age-adjusted prevalence of overweight, obesity, and extreme obesity among the United States adults aged 20 and over

Sample size and weight status	NHANES 1988-1994	NHANES 1999-2000	NHANES 2001-2002	NHANES 2003-2004	NHANES 2005-2006	NHANES 2007-2008
Sample (n)	16,679	4,117	4,413	4,431	4,356	5,555
Overweight ($25 \leq BMI \leq 30$)	33.1%	34.0%	35.1%	34.1%	32.7%	34.2%
Obese ($BMI \geq 30$)	22.9%	30.5%	30.6%	32.2%	34.3%	33.8%
Extremely obese ($BMI \geq 40$)	2.9%	4.7%	5.1%	4.8%	5.9%	5.7%

NOTES: Age-adjusted by the direct method to the year 2000 U.S. Census Bureau estimates using the age groups 20-39, 40-59, and 60 years and over. From NCHS Health E-srars.

From prevalence of overweight, obesity, and extreme obesity among adults: United States, trends 1960–1962 through 2007–2008. National Center for Health Statistics.

Figure 4. Trends in overweight, obesity, and extreme obesity among adults aged 20-74 years: United States, 1960-2008.



From prevalence of overweight, obesity, and extreme obesity among adults: United States, trends 1960–1962 through 2007–2008. National Center for Health Statistics.

Fortunately, overweight and obesity are preventable. At the individual level, the WHO proposed people should limit their energy consumption from fats and sugar, eat healthy foods by increasing fruit and vegetable intake as well as whole grains and nuts, and engage in regular physical activity: at least 60 minutes per day for children, and at least 150 minutes of moderate activity per week in adults (7). In Carlson et al.'s study on inadequate physical activity and health care expenditures in the United States, they found an inadequate level of physical activity, less than 150 minutes per week in adults, was associated with $79 billion in health care expenditures per year (56). At the societal level, the community should support individuals to follow the recommendation given above through the political commitment and collaboration of private and public stakeholders. And lastly, the industry level can help to promote healthy diet by

decreasing fat, sugar, and salt content in foods, providing healthy and nutritious foods to all consumers at an affordable price, and supporting regular physical activity in the workplace (7).

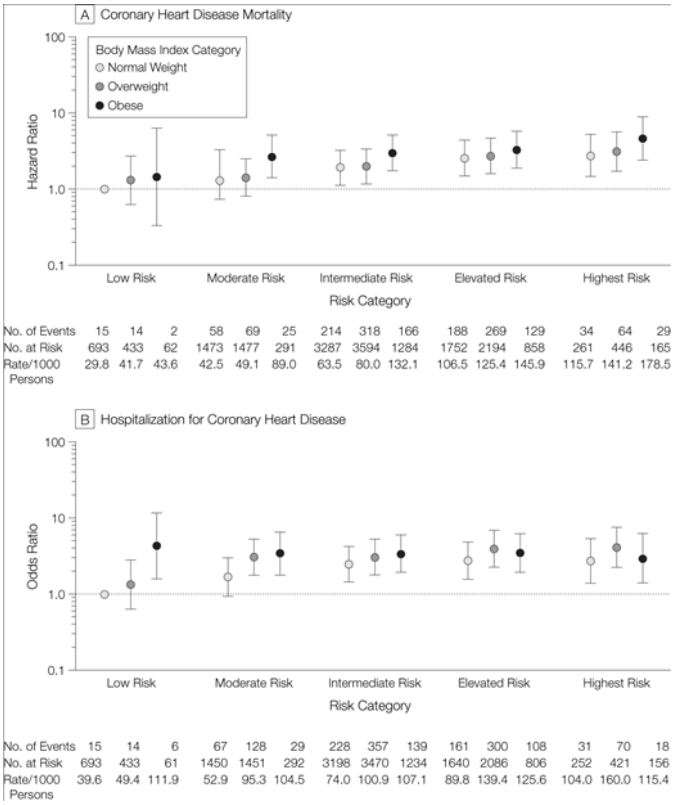
Obesity costs approximately $118 billion (calculated from direct costs, such as hospital stays, medicine, treatment, and doctor fee, and indirect costs, such as reduced productivity, missed workdays, and disability pensions) in the United States annually (10). These costs account for 12% of the United States health care expenditure, which is more than double the $47 billion health care expenditure associated with smoking. Moreover, a number of studies show that obesity increases the risk of many health problems, such as hypertension, cardiovascular disease, DM, and respiratory problems (13-16, 57, 58).

According to Field et al, being overweight increases the risk of developing diabetes, hypertension, heart disease, and cerebrovascular accident in both women and men (14). Adults who are overweight but not obese ($25.0 \leq BMI \leq 29.9$) have significantly increased risk of health conditions such as diabetes, hypertension, and heart disease compared to adults with healthy weight. Individuals who have BMI equal to or greater than 35 are approximately 20 times more likely to develop diabetes and 3 times more likely to develop hypertension as shown in Table 2.

Furthermore, published data from the Chicago Heart Association Detection Project in Industry study in 2006 showed that obesity in middle age increased the risk of hospitalization and mortality from coronary heart disease (CHD), cardiovascular disease, and diabetes (16). In this study participants were stratified into 5 levels of cardiovascular risk (low, moderate, intermediate, elevated, and highest risk) and 3 weight groups (normal, BMI 18.5-24.9; overweight, BMI 25.0-29.9, and obese, BMI $\geq$30). The results showed that obesity increased the likelihood of cardiovascular-related mortality as shown in Figure 5. In addition, the nation vital statistics report showed that diabetes, hypertension, and heart disease were major causes of death

in 2010 (17). Approximately 595,000 people and 69,000 people died from heart disease and diabetes respectively. In the same year, the data from the Medical Expenditure Panel Survey showed $253.3 billion were the total prescribing drug expenses by adults, which included metabolic agents, the highest expenses ($49 billion), and cardiovascular agents ($28 billion) (18).

Figure 5. Risk of mortality and hospitalization from coronary heart disease in older age, by midlife risk and body mass index category



From midlife body mass index and hospitalization and mortality in older age. JAMA 2006

Table 2. Ten-year risk (1986-1996) of developing an obesity morbidity among 77,690 female nurse and 46,060 male health professionals in the United States

	Adjusted Odds Ratios (95% CI)*			
	Diabetes	Hypertension	High Cholesterol Level	Heart Disease
	Women			
10-y risk of developing disease, %┼	5	14	58	3
Body mass index. Kg/ m^2				
< 25.0	Referent	Referent	Referent	Referent
25.0-29.9	4.6 (3.9-5.4)	1.7 (1.6-1.8)	1.1 (1.1-1.2)	1.4 (1.2-1.5)
30.0-34.9	10.0 (8.4-11.8)	2.1 (1.9-2.2)	0.9 (0.9-1.0)	1.5 (1.3-1.7)
≥ 35.0	17.0 (14.2-20.5)	2.3 (2.1-2.6)	0.7 (0.6-0.7)	1.5 (1.3-1.8)
	Men			
10-y risk of developing disease, % ┼	8	13	46	4
Body mass index. Kg/ m^2				
< 25.0	Referent	Referent	Referent	Referent
25.0-29.9	3.5 (2.9-4.1)	1.7 (1.6-1.8)	1.3 (1.2-1.3)	1.5 (1.4-1.7)
30.0-34.9	11.2 (9.3-13.6)	2.7 (2.4-3.0)	1.2 (1.1-1.3)	2.0 (1.7-2.3)
≥ 35.0	23.4 (19.4-33.2)	3.0 (2.3-3.9)	1.3 (1.1-1.6)	2.2 (1.5-3.1)

*Adjusted for age, smoking, and race. CI indicates confidence interval

┼Risk, estimate from logistic regression model, for a 50- to 59-year-old women or men who is white, never smoked, and has BMI < 25

Adapted from impact of overweight on the risk of developing common chronic diseases during a 10-year period. Archives of internal medicine. 2001.

The importance of Medication Adherence

What is medication adherence? According to the Agency for Healthcare Research and Quality, medication adherence refers to "the patient's conformance with the provider's recommendation with respect to timing, dosage, and frequency of medication taking during the prescribed length of time" (59). Even though there are many medications to treat many diseases, these medications often do not reduce mortality or morbidity because some patients do not adhere to taking their medications as prescribed from health care providers. Some studies show medication adherence has an important role to improve treatment outcomes in diseases such as heart disease, hypercholesterolemia, diabetes and hypertension (28-30, 60).

Medication non-adherence is an important health care problem especially in patients with chronic diseases. For example, a systematic review on interventions for helping patients to take their medication as prescribed by Haynes et al. analyzed randomized controlled trials and demonstrated that only 50% of patients with chronic diseases in developed countries adhere to their medications (61). In Pittman et al.'s study on adherence to statins (the primary drug class used to decrease low-density lipoprotein cholesterol [LDL]), they found nearly one-third of their patients were not adhering to statins in the baseline year, and non-adherence was associated with $400 to $900 per patient (25). Suppose extrapolating the results of Pittman et al. to around 24 million people who receive statins in the United States, by only increasing medication adherence the country could potentially save more than $3 billion annually in healthcare expenditure (25). In David et al.'s study on management and treatment perceptions among young adults with asthma, they assessed management practices and treatment perceptions by using a postal questionnaire survey of 4,500 randomly selected adults aged 20-44 years old in Melbourne, Australia (62). They found that only 43% of patients with asthma took medications as prescribed

all of the time, and only 11% used prophylactic medication. This demonstrates that medication non-adherence is a crucial health care problem worldwide.

Approximately 80% of adults in the United States are taking at least one medication and nearly 30% are taking five or more medications. And 31-71% of the United States patients are non-adherent to medications taken four times per day, which results in an estimated $105 billion in preventable expenditure annually (21, 22, 24). Further, polypharmacy has increased since 2000, from 23% to 29 % in patients using five or more medications. Having a complex medication regimen increases likelihood of non-adherence (21). One might expect that in clinical trials the medication adherence rate should be high because of the attention of staff to patients, but clinical trials reported average adherence rates in chronic disease patients of only 34 to 97% (21, 23).

Many tools have been used to measure medication adherence, for example: the Drug Attitude Inventory (DAI) that was developed by Hogan et al.(63), the Morisky Medication Adherence Scale (MMAS) that was developed by Morisky et al. (46-48), and the Medometer that was developed by Hansen et al (45). Each tool has some advantages and some disadvantages.

The Drug Attitude Inventory (DAI) is a 30-item self-reported questionnaire that was developed by Hogan and colleagues in 1983 (63). The DAI-30 contains 15 items that fully adherent patients would answer “True” and 15 items that such a patient would answer “False”. A positive total score indicates adherent, while, a negative total score indicates non-adherent. One disadvantage of DAI is the number of items given that it may be difficult to complete all 30 items within a few minutes. One advantage of DAI is that this questionnaire can determine attitudes and beliefs of the patient towards the doctor.

The Morisky Medication Adherence Scale (MMAS) is an 8-item self-reported

questionnaire developed by Morisky and colleagues in 2008 (48). The Cronbach's alpha of the 8-item instrument was 0.83 (n=1,367). This questionnaire has been used to determine medication adherence during the past two weeks. Adherence level is indicated from a total score: total score equal to 8 indicates high adherence, total score 6 to <8 indicates medium adherence, and total score less than 6 indicates low adherence. Two disadvantages of the MMAS are the scoring guidelines do not identify a cut-off score for non-adherence and this is a self-reported measurement that may have a recall bias. Some advantages of the MMAS are brevity (only eight items), its use in many studies, and that it has been translated into many languages.

The Medometer is also a self-reported questionnaire, but this tool is a visual analog scale while other tools mentioned above are rating scales (45). The Medometer looks like a speedometer with a scale that ranges from 0% to more than 120%: 0% indicates the patient does not take medications at all, 100% indicates the patient takes all doses of medication as prescribed, and greater than 100% indicates the patient takes more doses of medication than prescribed. One advantage of the Medometer is it is easier for patients to assess their medication adherence behavior than using a rating scale.

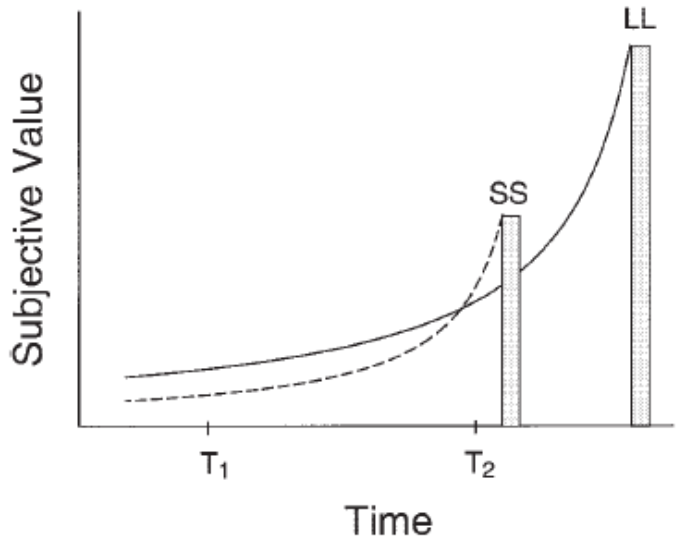
Impulsivity and Its Association with Health Behaviors

When making decisions regarding a course of action, individuals may consider the benefits that they will get and costs that they pay over a period of time. For instance, would they prefer to stay in bed for an extra hour rather than go to the gym to work out. Making a decision or action without considering the consequences of the action reflects short-sightedness, and often results in undesirable consequences. This is known as impulsivity (31). As a consequence, impulsivity can be characterized as acting "with relatively little forethought" (64). Other aspects of impulsivity include delayed rewards discounting and risk taking (65, 66). This study will

focus on impulsivity in the delayed rewards discounting aspect.

Delay discounting is a concept in behavioral economics that has been used to characterize an individual's level of impulsivity and refers to the idea that an individual will devalue the future to varying degrees, depending on how far in the future rewards are received (32). Delay discounting has been measured in various ways, but one method is to use a binary choice delay discounting task in which an individual will make a choice between a smaller sooner reward and larger, later reward (67). Tasks such as these are used to determine an indifference point at which the individual is indifferent between receiving the smaller reward now and waiting for the larger reward (68). Indifference points are then plotted on a graph to form a discounting curve to describe the delay discounting rate. In Figure 6, the vertical axis represents subjective value of a reward and the horizontal axis represents time. The curves show how subjective value changes over time.

Figure 6: Choice between smaller rewards, available sooner (SS) and larger rewards, available later (LL).



From a discounting framework for choice with delayed and probabilistic rewards.

Delay discounting has been used in both animal and human studies. In animal studies, delay discounting is used to assess the effect of delayed reinforcement of the animals' behavior. In these studies, the rewards are usually defined as food, and the animal subjects, such as rats will receive rewards by pressing a lever (69). In human studies, hypothetical rewards rather than real rewards are often utilized due to greater feasibility in studies, and previous studies have shown no difference in discounting rate using hypothetical versus real rewards (70). Comparing human studies with animal studies, most human studies require more sophisticated processes. This is an example question that will be used in human studies: "Would you prefer $50 now or $100 in a week?" Furthermore, various studies have also shown that delay discounting is influenced by many factors: gain or loss, the amount of the rewards, income, and age (71-74).

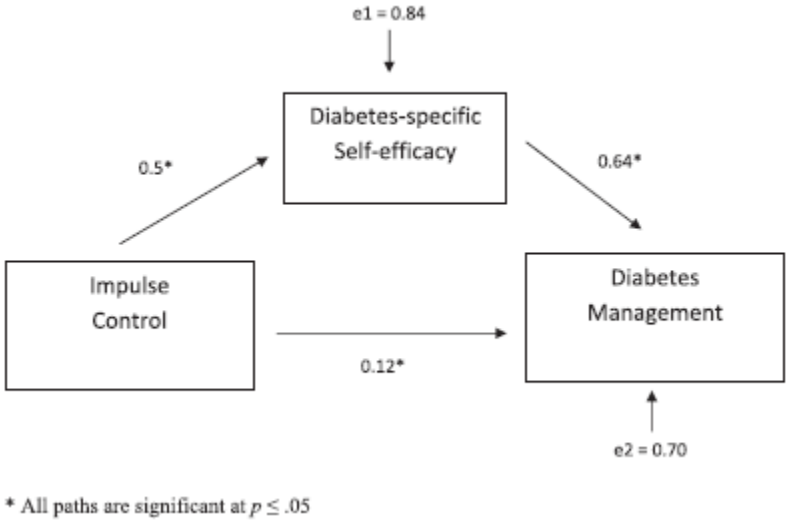
In regard to gain or loss, previous studies of hypothetical monetary payment and reward scenarios showed the delay discounting of hypothetical monetary gains is higher than hypothetical monetary losses (72, 73). For the amount of rewards, Green et al.'s study showed that degree of discounting rates decreased as the amount of the delayed rewards increases (71).

One of the procedures used to determine an individual's level of impulsivity is a delay discounting task that utilizes a decreasing-adjustment algorithm (75). For example, in Du et al., participants made choices between an immediate reward and a delayed reward. Each participant was presented with seven delays: 1 month, 3 months, 9 months, 2 years, 5 years, 10 years, and 20 years. In each condition of the delay task, the participants made six choices at each of the seven delays (for a total of 42 trials) and the first trial was a choice between a larger reward after a delay and exactly half of the delayed amount received immediately. In the following trial, the value of the smaller reward was increased or decreased by half of the previous adjustment, depending on the choice made by the individual participant in the previous trial. In this way an

indifference point can be determined.

Previous research in behavioral economics has shown that impulsivity is associated with patients' health behaviors (e.g. drug use, alcohol abuse, cigarette smoking, obesity, diet, and physical activity) (33-40). For instance, in Hjördis's study on a long-term behavior treatment program for obesity, the results showed that individuals who dropped out from the program had significantly higher impulsivity scores compared with individuals who completed the program (38). Jasinska's study on impulsivity and inhibitory control deficits and their association with unhealthy eating in young adults showed that impulsivity and inhibitory control deficits were positively associated with some aspects of unhealthy diet such as overeating and making food choices based on taste preference (39). Furthermore, in Garza's study on examination of value of the future and health beliefs to explain dietary and physical activity behaviors, participants who valued long term rewards (had low level of impulsivity) reported more healthful dietary behavior (40). In addition, Garza's study also showed people who valued long term rewards were more likely to engage in physical activity compared to people who value sooner rewards (40). In Brandt's study on time and risk preferences and the use of asthma controller medication, the result showed impulsivity was a significant predictor of adherence to asthma controller medication (76). In Stupiansky's study on diabetes management among early adults with type 1 diabetes (37), the results showed people who had greater impulse control have better diabetes management and showed diabetes-specific self-efficacy partially mediated the relationship between impulse control and diabetes management as shown in Figure 7.

Figure 7. Path analysis of mpulse control, diabetes-specific self-efficacy, and diabetes management



From impulse control, diabetes-specific self-efficacy, and diabetes management among emerging adults with type 1 diabetes

From the health perspective, various interventions for health behavior modification have been proposed, and many different theoretical models have been used as frameworks for these interventions including behavioral economics. Many chronic diseases are the long-term results of unhealthy behaviors such as poor diet and sedentary lifestyle, which often do not appear until far into the future. Accordingly, the value placed on future health may have an influence on the adoption of healthy behaviors to prevent progression of those diseases.

Chapter 3. Research Design and Methods

This chapter focuses on the methods that were used to gather data for this study. It describes the research design, study population, data collection method, and data analysis. This study has three specific aims:

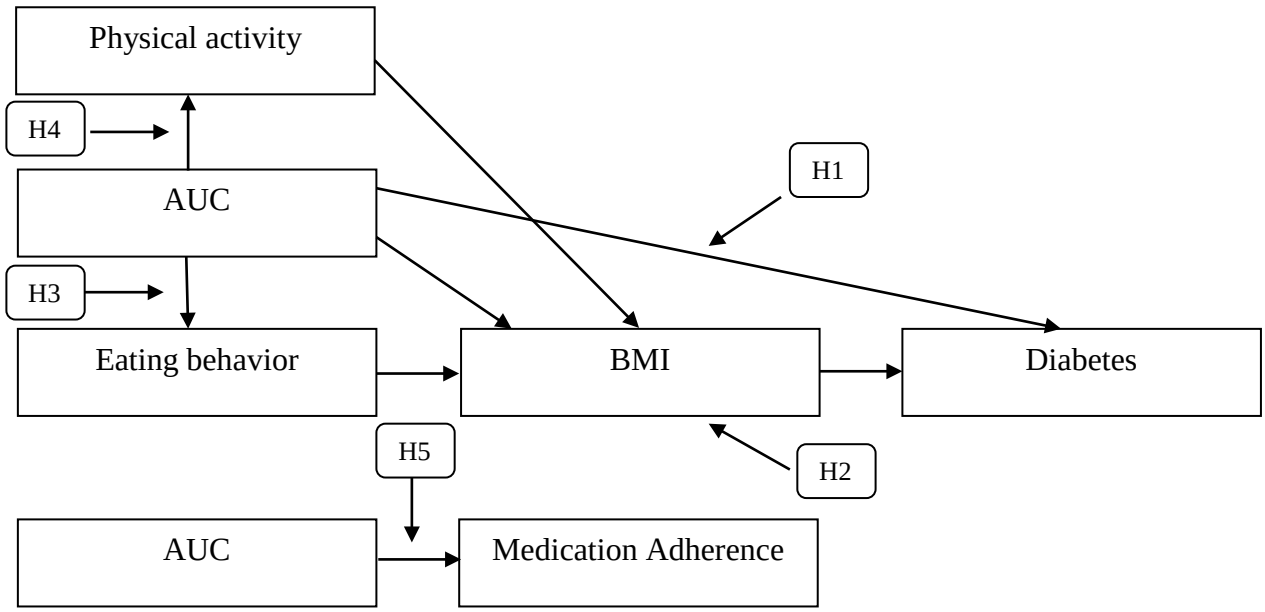
Specific Aim 1: Determine the association between level of impulsivity and diabetes, and test if BMI serves as a mediator.

Specific Aim 2: Determine the association between level of impulsivity and eating behaviors and the level of impulsivity and physical activity behaviors in adults.

Specific Aim 3: Determine the association between level of impulsivity and medication adherence in adults with diabetes.

Study Hypotheses

Figure 8. Model of hypothesized relationship between variables



AUC was used to operationalize the construct of impulsivity and associated with impulsivity in the opposite direction

H1. Impulsivity will have a direct association with diabetes in adults.

H2. BMI will be a mediator between level of impulsivity and diabetes in adults.

H3. Level of impulsivity will have an association with eating behavior in adults.

H4. Level of impulsivity will have an association with physical activity behavior in adults.

H5. Level of impulsivity will have an association with adherence to oral diabetes medications in adults with diabetes.

Research Design

A cross-sectional study was employed to address the research questions and test the above hypotheses. The target population in this study was Auburn University (AU) employees and their dependents who participated in the AU Healthy Tigers program, administered by the AU Pharmaceutical Care Center (AUPCC) at Auburn University. This study was divided into 4 major phases.

Phase 1: Survey Construction

The questionnaire in this study was built into an online survey via a program called Qualtrics. Qualtrics is a web-based survey software that allows a user to create surveys, collect and store data, and produce reports.

This study utilized five instruments to measure the level of impulsivity, eating behavior, physical activity behavior, and medication adherence (Table 3). The first instrument was a widely used delay discounting task to measure the level of impulsivity (40). The second was the Food Behavior Checklist (FBC) used for measuring eating behaviors (43). The third was the Global Physical Activity Questionnaire (GPAQ), which was used for measuring physical activity behavior (44). Next, the Morisky Medication Adherence Scale (MMAS) and the Medometer

were used for measuring medication adherence (45-48). Each instrument is described in detail in the paragraphs that follow.

The delay discounting task is an instrument that has been used to determine level of impulsivity (77). This instrument uses a binary choice delay discounting procedure. Participants chose between a smaller, sooner reward (SSR) and a larger, later reward (LLR). The starting point in this instrument for the SSR was $500. The starting point for the LLR was $1000 received after a specified delay. If the participant chose the SSR, the SSR in the subsequent trial was decreased by half of the amount of the previous trial. For instance, if the participant chose $500 now, the following choice was between $250 now and $1,000 one day from now. On the other hand, if the participant chose the LLR, the SSR in the subsequent trial was increased by half of the amount of the previous trial. For instance, if the participant chose $1,000 one day from now in the first choice, the subsequent choice offered was between $750 now and $1,000 one day from now. The value of the LLR remained constant at $1,000. The choices were adjusted in this way for a total of six choices presented for each delay. The value that would have been presented in the seventh trial was used as the indifference point, or the point at which the participant is theoretically indifferent between the SSR and LLR. A total of seven delays were utilized: one day, one week, one month, six months, one year, five years, and 25 years. Indifference points for each delay were plotted on a discounting curve, which was then used to calculate Area Under the Delay Discounting Curve (AUC). Delays and monetary amounts were normalized so that AUC values fell between 0 and 1. AUC is inversely related to the level of impulsivity, with high AUC representing low levels of impulsivity.

The Food Behavior Checklist (FBC) consists of 16 items that determine eating behavior in terms of fruits or vegetables, fat or cholesterol, milk, beverage consumption, and self-rated

healthfulness of diet (43). However, this study used only 15 items, excluding the self-rating of diet question. Scores were assigned to each item and summed to create a total score, ranging from 0 to 45, with higher scores indicating more healthful diet. Most items used a Likert-type scale. For example, "Do you eat more than one kind of vegetable each day?" Most items were scored: No (0), Yes, sometimes (1), Yes, often (2), and Yes, always (3). Two items were scored as "YES" (3) and "NO" (0). For the open-ended questions about number of servings per day of fruit and vegetables consumed, if the answer met the recommendation, it was scored as a 3. One item that asked if the participant takes the skin off chicken was scored: No (0), Yes, sometimes (1), Yes, often (2), Yes, always (3), and I don't eat chicken (3). Certain items were reverse scored so that higher scores represented more healthful behaviors.

The Global Physical Activity Questionnaire (GPAQ) was originally constructed to be administered as a telephone interview, and was adapted for this study to be self-administered via online survey. It consists of 16 items that assess self-reported physical activity in four domains: activity at work, travel to and from places, recreational activities, and sedentary behavior (44). However, our study excluded the last domain from calculating physical activity scores. The activity at work, travel to and from places, and recreational activities are divided into 5 sub-domains: vigorous work, moderate work, transport, vigorous recreation, and moderate recreation. This questionnaire was scored in terms of total metabolic equivalents (METs). One MET is defined as the energy cost of sitting quietly, and is equivalent to a caloric consumption of 1 Kcal/kg/hour. When calculating an overall energy expenditure, 4 METs was assigned to the time spent in moderate activities and 8 METs to the time spent in vigorous activities. The recommended amount of METs is 600 METs per week. Participants were divided into two

groups: people who meet the physical activity guideline and people who do not meet the physical activity guideline, which has been used in previous studies (78, 79).

The Morisky Medication Adherence Scale (MMAS) consists of 8-items that assess self-reported medication-taking behavior (46-48). In this questionnaire, participants indicate their behavior by choosing "YES" (0) or "NO" (1) in items 1 through 7. Item number 8, which asks, "How often do you have difficulty remembering to take all your medication(s)?", is a 5-point Likert-type scale: Never/Rarely (4), Once in a while (3), Sometimes (2), Usually (1), and All the time (0). To calculate the total scores, items were reverse coded in the positive direction and the code standardized for item 8 (0-1).This study adapted the Morisky to measure adherence to individual medications rather than all medications together in order to compare it to the Medometer, which has used the same methodology (45).

The Medometer is a visual analog scale that assesses self-reported medication-taking behavior (45). The scale ranges from 0% to more than 120%: 0% indicates no doses taken, 100% indicates all doses taken as prescribed, greater than 100% indicates that more than the prescribed number of doses are taken. In the current study, a specific time frame for measuring medication adherence was not specified.

This questionnaire was reviewed by colleagues in the Health Outcomes Research Department in order to ensure clarity, readability, and construct validity. Participants self-reported what diabetes medications that they were currently taking by choosing from a list of diabetes medications, which included generic name and brand name (Table 3). If participants reported more than one medication, the sum of all medication adherence scores were divided by the number of diabetes medications that they reported to create an average adherence score for purposes of data analyses.

Table: 3 List of diabetes medications in this survey

1. Acarbose (Precose)	2. Glimepiride (Amaryl)
3. Glipizide (Glucotrol, Glucotrol XL)	4. Glyburide (DiaBeta, Glynase Pres Tab, Micronase)
5. Metformin (Fortamet, Glucophage, Glucophage XR, Glumetza, Riomet)	6. Miglitol (Glyset)
7. Nateglinide (Starlix)	8. Pioglitazone (Actos)
9. Repaglinide (Prandin)	10. Rosiglitazone (Avandia)
11. Sitagliptin (Januvia)	12. Tolazamide (Tolinase)
13. Actoplus (Metformin and Pioglitazone)	14. Avandamet (Metformin and Rosiglitazone)
15. Avandaryl (Rosiglitazone and Glimepiride)	16. Duetact (Pioglitazone and Glimepiride)
17. Janumet (Metformin and Sitagliptin)	18. Metaglip (Glipizide and Metformin)

Table: 4 Type of data and measurement

Variable	Instrument	Number of Items	Scale
Level of impulsivity	Delay discounting task (Continuous data)	42	0-1
Eating behavior	The Food Behavior Checklist (FBC) (Continuous data)	15	0-45
Physical activity	The Global Physical Activity Questionnaire (GPAQ) (Continuous data converted to Categorical data – meets or does not meet the physical activity guideline)	15	0-53,760
Medication Adherence	The Morisky Medication Adherence Scale (MMAS) (Continuous data & categorical data)	8	0-8
	The Medometer (Continuous data)	1	0-120
Diagnosis of diabetes	Self-reported (Categorical data)	1	Yes/No
Demographic data	Height, Weight, Sex, Date of birth, Marital Status, Education level, Household income, Race, Work position (Continuous data & categorical data)		

Phase 2: Recruitment

The target population in this study was Auburn University (AU) employees and their dependents who participated in the AU Healthy Tigers program. Auburn University had 10,711 main campus employees, with approximately 3,730 of them having participated in the AU Healthy Tigers program. According to the Lee County data, the adult obesity rate in this area is approximately 30% and the adult diabetes rate in this area is approximately 9%. To recruit people to participate in this study, we sent an invitation email to all eligible AU employees and their dependents using an electronic mail distribution list (n=3,730). The invitation email contained general information about the study, objective of the study, and a link to the online survey. In the online survey, participants answered the questionnaire, which included: demographics, general health information, level of impulsivity, eating behavior, and physical activity behavior. Participants who self-reported a diagnosis of diabetes and indicated that they currently take one or more oral medications to treat diabetes completed two additional instruments regarding medication adherence.

Phase 3: Survey launch

This study was approved by the Auburn University Institutional Review Board. The online survey was launched on June 16, 2015 and it closed on July 22, 2015. Based on previous data collection in this field, which have a response rate range from 20-40 %, we expected to have 1,000 people participate in this study. This study had 18.50% response rate (690 people). Participants who agreed to participate in the study completed the questionnaire via online survey. A reminder email was sent to all non-responders after the survey was available for two weeks, and another reminder email was sent to all non-responders by the end of week three. Data were downloaded from the secure Qualtrics server for analysis.

Phase 4: Data cleaning and analysis

Descriptive statistics were used to characterize the sample. To test for the association between level of impulsivity and diabetes in adults and BMI as a mediator of this association, the association between level of impulsivity and eating behaviors and the level of impulsivity and physical activity behavior in adults, and the association between level of impulsivity and medication adherence in adults with diabetes, statistical analyses were performed using SAS version 9.4 (SAS Institute, Inc., Cary, NC) at significance level $P<0.05$. Pearson correlation coefficients, Spearman correlation coefficients, linear regression, and multinomial logistic regression were estimated using the SAS procedure, PROC TTEST, PROC FREQ, PROC REG, PROC GLM, PROC logistic.

For regressions, if independent variables showed high degree of correlation with each other, one of them would be dropped from the model. However, if they have been demonstrated to be an important factor in previous literature, both of them were included in regression model. To fit the best linear regression model, our study performed three different methods: forward selection, backward elimination, and stepwise selection. The best regression model was selected by considering the Akaike information criterion (AIC).

To deal with nonresponse bias, which might occur when people who did not respond to a survey are different from those who did, we compared early responders with late responders. Early responders were defined as the first 150 people who completed the survey, whereas, late responders were defined as the last 150 people who completed the survey. We compared both groups on 8 variables: 4 background characteristics (sex, marital status, education level, and household income), AUC, BMI, eating behavior, and physical activity. However, we did not compare them on medication adherence because of the low number of respondents to these

measures.

Chapter 4. Results

This chapter addresses each study aim by reporting the results of analyses of survey responses. First, a description of participant sociodemographic characteristics, impulsivity, eating behavior, physical activity, and medication adherence is demonstrated. Second, Pearson correlation and Spearman correlation coefficients are reported to demonstrate the bivariate associations between these variables. Then, the results regarding the association between impulsivity and diabetes are described (H1). Next, a model of the relationship between impulsivity, BMI, and diabetes is included (H2). Finally, the association between impulsivity and eating behavior (H3), impulsivity and physical activity (H4), and impulsivity and medication adherence (H5) is reported

Participant Demographic Characteristics and Their Associations with Outcome Variables

A total of 690 participants responded to the survey. After excluding those responses that did not meet the criteria, for example, people who indicated they did not wish to take the survey and those who did not complete food behavior checklist, the number of eligible responses included in the analyses was 612. However, some of these participants did not complete all sections of the survey, resulting in some missing data.

The distribution of sociodemographic characteristics are demonstrated in Table 5 and are broken down by self-reported diagnosis of diabetes. The sociodemographic characteristics include: sex, marital status, education level, household income, and race/ethnicity. Overall, approximately 73% of participants were female, 65% of participants were currently married, 50% of participants completed a graduate or professional degree, 35% of participants had a

household income between $20,000 to 59,999 per year, and 86% of participants were white or Caucasian.

Table 5 Distribution of sociodemographic characteristics (N = 612)

Characteristics	Overall N (%)	Participants without diabetes N = 556 (%)	Participants with diabetes N = 56 (%)
Sex			
• Male	165 (27.14)	148 (26.81)	17 (30.36)
• Female	443 (72.86)	404 (73.19)	39 (69.64)
Marital Status			
• Single	110 (18.06)	101 (18.26)	9 (16.07)
• Currently married	398 (65.36)	363 (65.64)	35 (62.50)
• Separated, divorced or widowed	101 (16.58)	89 (16.10)	12 (21.43)
Education Level			
• Less than high school	0 (0)	0	0
• High school	26 (4.27)	24 (4.34)	2 (3.57)
• Some College	68 (11.17)	60 (10.85)	8 (14.29)
• Bachelor's or Associate degree	213 (34.98)	190 (34.36)	23 (41.07)
• Graduate or Professional degree	302 (49.59)	279 (50.45)	23 (41.07)
Household income			
• Less than $20,000 per year	4 (0.66)	3 (0.55)	1 (1.82)
• $20,000 to 59,999 per year	214 (35.49)	191 (34.85)	23 (41.82)
• $60,000 to 99,999 per year	199 (33.00)	180 (32.85)	19 (34.55)
• $100,000 to 129,999 per year	80 (13.27)	75 (13.69)	5 (9.09)
• $130,000 or more per year	106 (17.58)	99 (18.06)	7 (12.72)

Race			
• White/Caucasian	523 (85.88)	482 (87.16)	41 (73.21)
• Black/African American	55 (9.03)	43 (7.78)	12 (21.43)
• American Indian or Alaska Native	3 (0.49)	3 (0.54)	0
• Asian	8 (1.31)	7 (1.27)	1 (1.79)
• Pacific Island	0 (0)	0	0
• Other	8 (1.31)	8 (1.45)	0
• Two or more	12 (1.97)	10 (1.80)	2 (3.57)
BMI			
• ≤ 24.99	211 (34.82)	207 (37.57)	4 (7.27)
• 25.0 – 29.99	197 (32.51)	184 (33.39)	13 (23.64)
• ≥ 30.00	198 (32.67)	160 (29.04)	38 (69.09)

It is well-documented that obesity is one of the primary risk factors for diabetes. To classify individuals as normal weight, overweight, or obese, we used BMI. Overweight was defined as BMI 25.0 – 29.9 and obese was defined as BMI ≥30. Our study used BMI as a continuous variable to analyze the association because we want more power to predict the outcome in regression. If we use the BMI as a categorical variable instead of a continuous variable, then the standard error on the regression coefficient will be large and power is low compared with the regression using a continuous variable (lower degree of freedom).

We tested the bivariate associations between BMI, AUC, eating behavior, physical activity, and medication adherence (Morisky and Medometer) and each of the sociodemographic characteristics (Table 6). Categorical variables were tested by using chi-square and continuous variables were tested by using independent sample t-test, ANOVA, Wilcoxon-Mann Whitney, or Kruskal Wallis, depending on the nature of variables and the distribution. Overall, the results

showed that AUC had a significant association with all sociodemographic variables: sex, marital status, education level, and household income. However, these analyses were conducted based on each variable individually and were not adjusted using other variables.

Table 6 Body mass index, AUC, eating behavior, physical activity, and medication adherence on sociodemographic characteristics (N=612)

Characteristics	BMI	AUC	Eating behavior	Morisky medication adherence	Medometer medication adherence	Does not meet physical activity guideline N (%)	Meets physical activity guideline N (%)
Sex							
Male	26.68 (3.11)	0.41 (0.17)*	26.56 (6.52)	7.88 (0.13)	100.00 (0)	62 (20.95)*	96 (32.43)*
Female	27.34 (4.45)	0.29 (0.18)*	26.51 (5.86)	6.75 (1.00)	98.5 (2.50)	234 (79.05)*	200 (67.57)*
Marital Status							
Single	27.44 (4.51)	0.34 (0.21)*	24.62 (5.90)*	6.72 (0.83)*	100.00 (1.00)	50 (16.89)	58 (19.53)
Currently married	26.60 (3.83)	0.36 (0.18)*	27.30(5.55)*	6.99 (1.08)*	99.90 (0.50)	190 (64.14)	196 (65.99)
Separated, divorced or widowed	28.32 (3.25)	0.22 (0.13)*	26.25 (5.00)*	5.47 (2.23)*	90.00 (10.0)	56 (918.92)	43 (14.48)
Education Level							
Less than high school	-	-	-	-	-	-	-
High school	30.22 (2.74)*	0.19 (0.17)*	25.03 (3.75)*	8.00 (0)*	100.00 (0)	19 (6.42)*	7 (2.36)*
Some college	28.77 (4.20)*	0.22 (0.17)*	25.68 (5.67)*	6.00 (1.00)*	98.00 (3.00)	40 (13.51)*	26 (8.75)*
Bachelor's or Associate degree	27.44 (3.91)*	0.28 (0.15)*	25.04 (5.10)*	6.50 (0.75)	95.00 (5.00)	108 (36.49)*	100 (33.67)*
Graduate or Professional degree	25.77 (3.53)*	0.38 (0.18)*	28.29 (5.64)*	7.25 (0.75)*	100.00 (0.10)	129 (43.58)*	164 (55.22)*

Household income							
less than $20,000 per year	27.43 (1.20)*	0.31 (0.22)*	31.45 (8.16)*	-	-	1 (0.34)	3 (1.02)
$20,000 to 59,999 per year	28.82 (4.25)*	0.28 (0.22)*	24.62 (5.20)*	6.00 (1.00)	98.00 (3.00)	111 (37.76)	96 (32.76)
$60,000 to 99,999 per year	26.94 (3.92)*	0.34 (0.22)*	26.84 (5.68)*	7.00 (1.00)	99.90 (0.50)	105 (35.71)	89 (30.38)
$100,000 to 129,999 per year	25.82 (3.91)*	0.38 (0.20)*	28.14 (5.31)*	5.75 (1.00)	95.00 (5.00)	34 (11.56)	46 (15.70)
$130,000 or more per year	25.96 (3.32)*	0.40 (0.20)*	28.65 (5.32)*	8.00 (0)	100.00 (0)	43 (14.63)	59 (20.14)

Categorical variables tested by chi-square, continuous variables with normal distribution tested by ANOVA or t-test (Mean (S.D)), continuous variables with non-normal distribution tested by Wilcoxon test (Median (MAD))

Associations between outcome variables

Pearson correlation and Spearman correlation coefficients were calculated to test correlations among variables, including diagnosis of diabetes, AUC, age, BMI, education level, sex, eating behavior, physical activity, and medication adherence, shown in Table 7. Overall, AUC was positively correlated with education, household income, eating behavior, and physical activity, but was negatively correlated with BMI. Eating behavior was positively correlated with AUC, age, education, and income, but was negatively correlated with BMI. Meeting the physical activity guideline was positively correlated with AUC, education, and eating behavior, and negatively correlated with age and BMI. Further, no variables were significantly correlated with medication adherence.

Table 7 Correlation coefficients among variables

	AUC	Age	BMI	Education	Income	Eating behavior	Physical activity	Medication adherence
AUC	1.0000							
Age	0.0063 0.8777	1.0000						
BMI	0.1544 **0.0001**	0.0958 **0.0184**	1.0000					
Education	0.2042 **<.0001**	-0.1379 **0.0006**	-0.1671 **<.0001**	1.0000				
Income	0.1833 **<.0001**	0.1527 **0.0002**	-0.1671 **<.0001**	0.3367 **<.0001**	1.0000			
Eating behavior	0.1833 **<.0001**	0.1527 **0.0002**	-0.1247 **0.0022**	0.2217 **<.0001**	0.2206 **<.0001**	1.0000		
Physical activity	0.1738 **<.0001**	-0.1407 **0.0006**	-0.1602 **<.0001**	0.1378 **0.0008**	0.0808 0.0505	0.2004 **<.0001**	1.0000	
Medication adherence	-0.0067 0.9659	0.2619 0.0860	-0.0592 0.7026	0.1338 0.3868	0.1936 0.2135	0.1731 0.2669	-0.0453 0.7786	1.00000

Continuous variables tested by Pearson correlation, categorical variables tested by Spearman correlation
AUC was used to operationalize the construct of impulsivity and associated with impulsivity in the opposite direction

Hypothesis 1: Impulsivity will have a direct association with diabetes in adults

The delay discounting task was used to determine level of impulsivity in this study. After indifference points were calculated for each delay, they were used to calculate normalized area under the delay discounting curve (AUC) by using the trapezoidal method. Normalized AUC values are indirectly associated with impulsivity, with higher AUC values representing lower level of impulsivity.

The association between impulsivity and diabetes was tested by logistic regression. Univariable (unadjusted) logistic regressions were performed among diagnosis of diabetes and individual predictors and multivariable (adjusted) logistic regressions were performed to test the significance of predictors (Table 8). We performed adjusted logistic regressions by using all predicted variables. The model selection was performed by forward selection, backward elimination, and stepwise selection. The best model was selected based on a model that has significant variable and has the lowest the Akaike information criterion (AIC).

Overall, the results of the univariable logistic regressions with all individual predictors showed that diagnosis of diabetes was significantly associated with age and BMI, , but was not associated with AUC. The odds of diagnosis of diabetes increased with increasing age (OR=1.053, CI=1.026, 1.080) and BMI (OR=1.133, CI=1.093, 1.175). Further, age and BMI were also significantly associated with diagnosis of diabetes in multivariable logistic regressions (Model 1). After analysis by 3 different methods, all of them showed the same results that only age and BMI were significantly associated with diagnosis of diabetes (Model 2). The results of multivariable logistic regressions showed that odds of having a diagnosis of diabetes increased with increasing age (OR=1.061, CI=1.030, 1.093) and BMI (OR=1.139, CI=1.096, 1.183).

Table 8 Univariable and multivariable logistic regression of diagnosis of diabetes and predictors

Variable	Univariable Logistic		Multivariable Logistic Model 1		Multivariable Logistic Model 2	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
AUC	0.189 – 1.874	0.3749	0.354 – 4.446	0.7256	-	-
Sex	0.461 – 1.531	0.5700	0.338 – 1.389	0.2945	-	-
Age	1.026 – 1.080	**0.0001**	1.031 – 1.095	**<0.0001**	1.030 – 1.093	**<0.0001**
Body Mass Index	1.093 – 1.175	**<0.0001**	1.098 – 1.190	**<0.0001**	1.095 -1.183	**<0.0001**
College	0.317 – 8.088	0.5694	0.356 – 10.850	0.43887	-	-
Bachelor's degree or associate's degree	0.322 – 6.549	0.6270	0.464 – 11.488	0.3071	-	-
Graduate or professional degree	0.220 – 4.450	0.9888	0.324 – 8.290	0.5510	-	-

Sex reference = male, Education level reference = high school level
AUC was used to operationalize the construct of impulsivity and associated with impulsivity in the opposite direction

Further, we also tested two interaction terms (AUC x age, age x BMI) in unadjusted and adjusted logistic regressions. The results of multivariable logistic regressions with interaction terms showed that only the interaction term (AUC x age) was significant in model 2 (p=0.0435) (Table 9). To select the best model for performing multivariable logistic regressions, we used three different methods: forward selection, backward elimination, and stepwise selection. The best model was selected based on a model that has significant variable and had the lowest the Akaike information criterion (AIC)

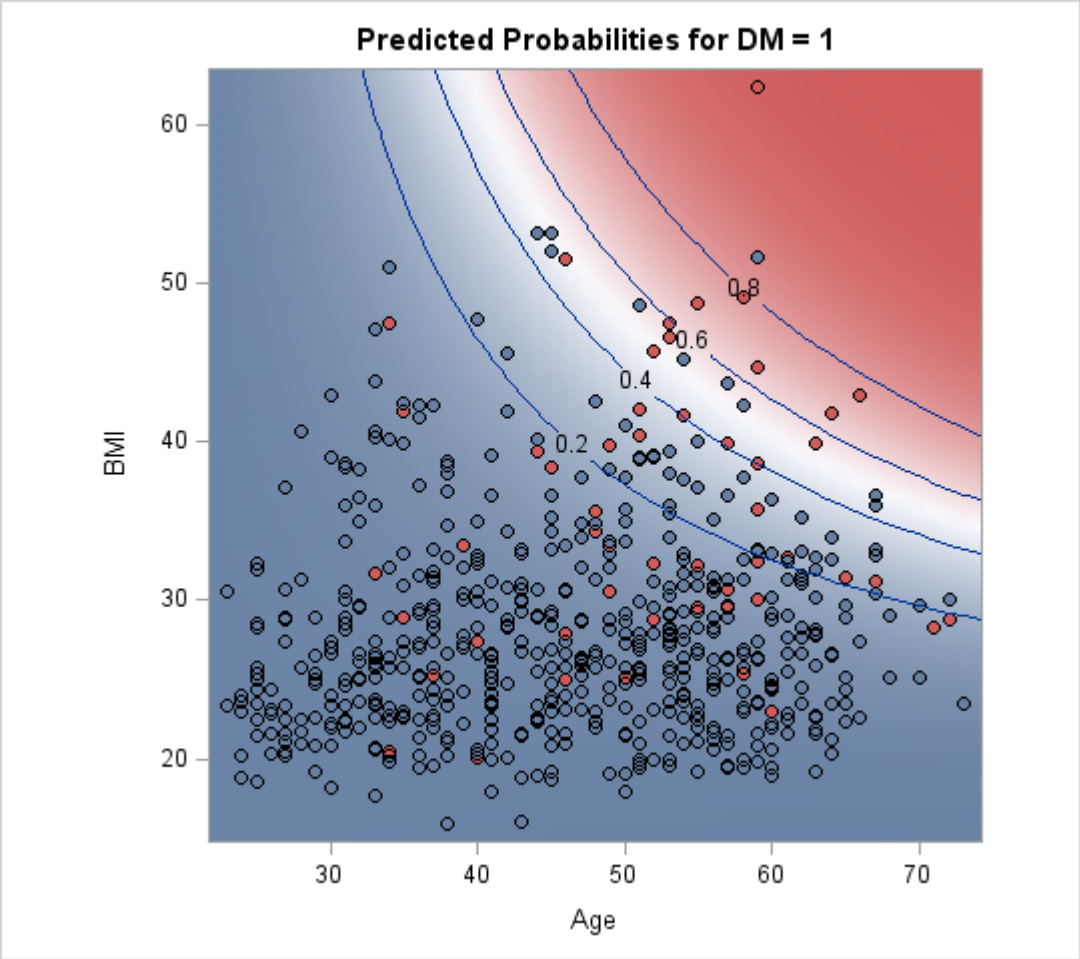
Table 9 Univariable and multivariable logistic regression of diagnosis of diabetes for interaction terms

Variable	Univariable Logistic		Multivariable Logistic Model 1		Multivariable Logistic Model 2	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
AUC	0.595 0.189 – 1.874	0.3749	-	-	-	-
Age	1.053 1.026 – 1.080	**0.0001**	1.061 1.030 – 1.093	**<0.0001**	0.926 0.811 – 1.057	0.2528
AUC x Age	1.005 0.984 – 1.027	0.6171	-	-	-	-
BMI	1.133 1.093 – 1.175	**<0.0001**	1.138 1.096 – 1.183	**<0.0001**	0.922 0.749 – 1.133	0.4395
BMI x Age	1.002 1.002 – 1.003	**<0.0001**	-	-	1.004 1.000 – 1.009	**0.0435**

AUC was used to operationalize the construct of impulsivity and associated with impulsivity in the opposite direction

Due to the results of multivariable logistic regressions with interaction terms, which showed significant interaction between age and BMI (OR=1.004, CI=1.000, 1.009), we plotted the graph between interaction term (age x BMI) and diagnosis of diabetes (Figure 9). When age and BMI increased, the probability of having diabetes also increased. AUC was not found to be significantly associated with diagnosis of diabetes in either unadjusted or multivariable adjusted models.

Figure 9. The relationship among age, BMI, and diagnosis of diabetes



Hypothesis 2: BMI will be a mediator between level of impulsivity and diabetes in adults

According to previous studies to test mediation, we should test four associations (80, 81). First, test the association between independent variable and dependent variable by using independent variable as a predictor. Second, test the association between mediator variable and independent variable by using independent variable as a predictor. Third, test the association between mediator variable and dependent variable by using mediator variable as a predictor. Lastly, test whether the association between independent variable and dependent variable was attenuated by the addition of the mediator variable as a predictor. After testing the association

between impulsivity and diabetes, it was not significant (p=0.3749). Then we did not test this hypothesis.

H3. Level of impulsivity will have an association with eating behavior in adults

To explore the association between level of impulsivity and eating behavior, first, Pearson correlation coefficients were calculated to test the association between eating behavior and predictors (Table 10). Overall, Pearson correlations and Spearman correlations between eating behavior and predictors showed eating behavior was correlated with all predictors. Eating behavior was positively correlated with AUC (r=0.1833, p<0.0001). In other words, greater AUC (lower impulsivity) was associated with a more healthful diet. Eating behavior was also positively correlated with age (r=0.1527, p=0.0002), education (r=0.1872, p<0.0001), and income (r=0.2206, p<0.0001), but was negatively correlated with BMI (r=-0.2147, p=0.0022). Further, all variables were correlated with each other except AUC and age.

Table 10 Correlation coefficient between eating behavior and predictors including interaction term

	Eating Behavior	AUC	Age	BMI	Education	Income
Eating Behavior	1.00000					
AUC	0.18330 **<.0001**	1.00000				
Age	0.1527 **0.0002**	0.0063 0.8777	1.00000			
BMI	-0.1247 **0.0022**	-0.1544 **0.0001**	0.0958 **0.0184**	1.00000		
Education	0.1872 **<.0001**	0.2042 **<.0001**	-0.1379 **0.0006**	-0.1671 **<.0001**	1.00000	
Income	0.2206 **<.0001**	0.1763 **<.0001**	0.2007 **<.0001**	-0.1603 **<.0001**	0.3367 **<.0001**	1.00000

Continuous variables tested by Pearson correlation, categorical variables tested by Spearman correlation
AUC was used to operationalize the construct of impulsivity and associated with impulsivity in the opposite direction

Second, univariable linear regression and multiple linear regression analyses were performed. The final model was selected by using Akaike's information criterion and degree of freedom (Table 11). Overall, multiple linear regression analysis showed that AUC, age, and marital status were associated with eating behavior scores in all three groups. Further, females reported more healthful eating behaviors compared to males and participants who completed a graduate or professional degree reported more healthful eating behaviors compared to those who finished only high school.

Table 11 Univariable and multivariable linear regression analyses for eating behavior in participants

Variable	Univariable linear regression		Multivariable linear regression		Multivariable linear regression*	
	Coefficients	P Value	Coefficients	P Value	Coefficients	P Value
AUC	4.4571	**<0.0001**	3.5715	**0.0004**	3.3920	**0.0002**
Age	0.0902	**<0.0001**	0.0915	**<0.0001**	0.0871	**<0.0001**
BMI	-0.1583	**<0.0001**	-0.0743	**0.0376**	-0.0815	**0.0104**
Sex (Male)	Reference		Reference		Reference	
Sex (Female)	0.0196	0.9721	1.4503	**0.0103**	1.1598	**0.0216**
Marital (Single)	Reference		Reference		Reference	
Marital (Current Married)	3.0867	**<0.0001**	2.0493	**0.0020**	1.9770	**0.0011**
Marital (Divorce or widowed)	2.0007	**0.0165**	1.2106	0.1585	1.1801	0.1305
Education (HS)	Reference		Reference		Reference	
College	0.3745	0.7862	0.2566	0.8501	0.2737	0.8255
Bachelor's degree or associate's degree	0.0751	0.9515	0.8040	0.5154	0.9431	0.4020
Graduate or professional degree	3.1679	**0.0093**	3.4438	**0.0053**	3.7641	**0.0008**

* After removal of observations having a studentized residuals outside ±2 range
AUC was used to operationalize the construct of impulsivity and associated with impulsivity in the opposite direction

H4. Level of impulsivity will have an association with physical activity behavior in adults

To test the association between impulsivity (AUC) and physical activity behavior, the continuous physical activity variable was converted to a binary outcome: met recommendation (≥ 600 METs) and did not meet recommendation (≤ 600 METs). Overall, unadjusted and adjusted logistic regression of physical activity and predictors, including an interaction term

(AUC x age), are shown in Table 12. The model selection was performed by forward selection, backward elimination, and stepwise selection. The best model (Model 2) was selected based on a model that has significant variable and had the lowest Akaike information criterion (AIC). The results showed all individual predictors were statistically significant in unadjusted logistic regression except marital status, while adjusted logistic regression analysis showed that physical activity was statistically significantly associated with AUC (p=0.0006), age (p=0.0006), BMI (p=0.0012), and sex (p=0.0132). These showed that as AUC increased (or impulsivity decreased), odds of meeting the recommendation increased (OR=3.452, CI=1.701, 7.007).

Table 12 Univariable and multivariable logistic regression of physical activity and predictors

	Univariable Logistic		Multivariable Logistic Model 1		Multivariable Logistic Model 2	
Variable	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
AUC	4.714 (2.391 – 9.294)	**<0.0001**	2.270 (0.118 – 43.683)	0.5870	3.452 (1.701 – 7.007)	**0.0006**
Age	0.976 (0.962 – 0.990)	**0.0007**	0.974 (0.947 – 1.002)	0.0669	0.975 0.960 – 0.989	**0.0006**
AUC x Age	1.020 (1.006 – 1.033)	**0.0036**	1.008 (0.947 – 1.073)	0.8034	-	-
Body Mass Index	0.949 (0.925 – 0.973)	**<0.0001**	0.959 (0.935 – 0.985)	**0.0020**	0.958 0.933 – 0.983	**0.0012**
Sex	0.552 (0.381 – 0.800)	**0.0017**	0.651 (0.436 – 0.971)	**0.0356**	0.610 0.413 – 0.902	**0.0132**
Currently married	0.889 (0.580 – 1.364)	0.5908	0.979 (0.613 – 1.563)	0.9291	-	-
Divorce or widowed	0.662 (0.382 – 1.146)	0.1405	0.939 (0.511 – 1.726)	0.8386	-	-
College	1.764 (0.651 – 4.783)	0.2646	1.590 (0.571 – 4.429)	0.3747	-	-
Bachelor's degree or associate's degree	2.513 (1.013 – 6.233)	**0.0467**	1.794 (0.701 – 4.592)	0.2231	-	-
Graduate or professional degree	3.451 (1.408 – 8.460)	**0.0068**	1.999 (0.785 – 5.094)	0.1466	-	-

Sex reference = male, marital status reference = single, and education level reference = high school
AUC was used to operationalize the construct of impulsivity and associated with impulsivity in the opposite direction

H5. Level of impulsivity will have an association with medication adherence in adults with diabetes

Pearson correlation coefficients were calculated to assess the correlation between variables (Table 13) before testing the association between medication adherence and level of impulsivity in adults with diabetes by linear regression and logistic regression. Overall, AUC was correlated with BMI ($r=-0.3170$, $p=0.0360$) and BMI was correlated with number of medications ($r=0.3498$, $p=0.199$) and physical activity ($r=-0.4317$, $p=0.0048$). However, AUC was not significantly correlated with either of the medication adherence scores. A significant correlation was demonstrated between the Morisky and the Medometer ($r = 0.0604$, $p<0.0001$).

Table 13 Pearson correlation coefficient between medication adherence scores and other variables

	Morisky Adherence	Medometer Adherence	AUC	Age	BMI	ALL_MED
Morisky Adherence	1.0000					
Medometer Adherence	0.6043 **<.0001**	1.0000				
AUC	-0.0066 0.9659	0.1672 0.2780	1.0000			
Age	0.2619 0.0860	0.1510 0.3280	-0.0856 0.5808	1.0000		
BMI	-0.0592 0.7026	-0.2087 0.1740	-0.3170 **0.0360**	0.0360 0.8165	1.0000	
Number med	0.1775 0.2490	0.1970 0.1999	-0.0956 0.5372	0.1966 0.2008	0.3498 **0.0199**	1.0000

Number med = Total number of medications that participants self-reported they are currently taking
AUC was used to operationalize the construct of impulsivity and associated with impulsivity in the opposite direction

Univariable (unadjusted) and multiple (adjusted) linear regression analyses were performed (Table 14). The model selection was performed by forward selection, backward elimination, and stepwise selection. The best model was selected based on a model that has significant variable and had the lowest the Akaike information criterion (AIC). Overall, BMI showed statistically significant associations in unadjusted linear regression with Medometer adherence scores, however, no variables showed statistically significant associations in unadjusted linear regression on Morisky adherence scores. AUC, age, and interaction term (AUC x age) showed statistically significant associations ($p=0.0181$, $p=0.0007$, and $p=0.0184$, respectively) in adjusted linear regression on the Morisky medication adherence scores. On the other hand, only BMI showed a statistically significant association in adjusted linear regression on the Medometer medication adherence scores.

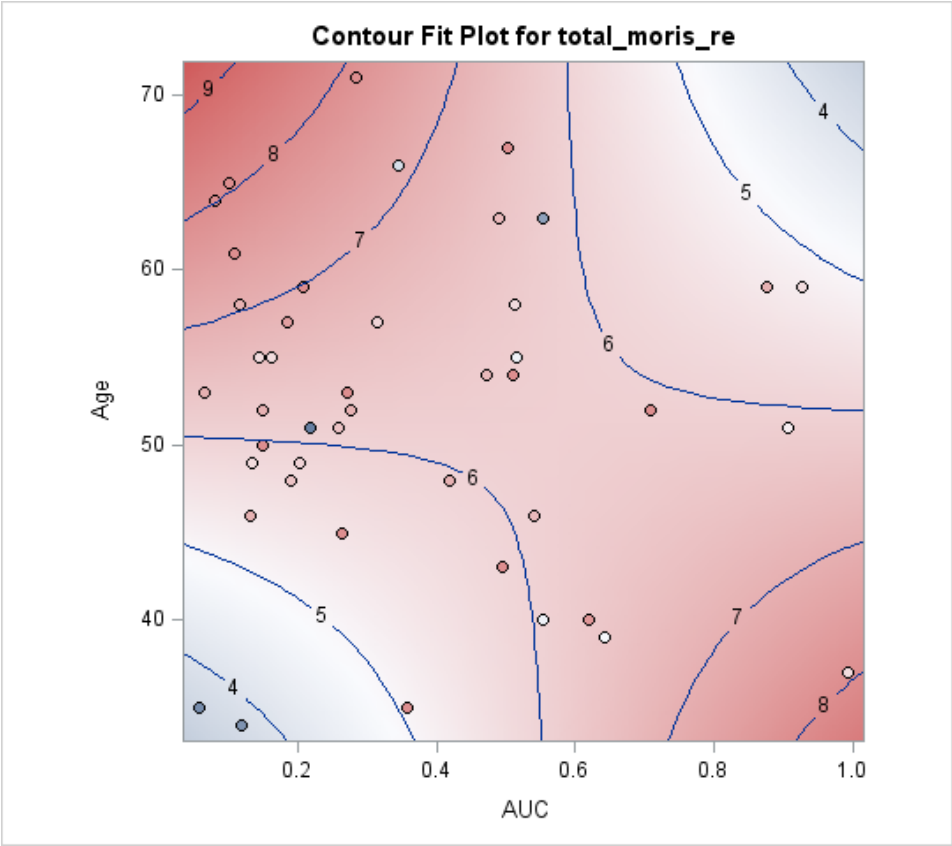
Table 14 Multivariable linear regression analyses for Morisky medication adherence and Medometer (N=44)

Variables	Univariate Linear regression (Morisky medication adherence)		Multiple Linear regression (Morisky medication adherence)		Univariate Linear regression (Medometer)		Multiple Linear regression (Medometer)	
	Coefficients	P	Coefficients	P	Coefficients	P	Coefficients	P
AUC	-0.1346	0.0689	12.6440	**0.0181**	-6.7184	0.2616	-	-
Age	0.0178	0.4300	0.1651	**0.0007**	0.0067	0.9685	-	-
AUC x Age	-0.0235	0.1072	-0.2452	**0.0184**	-0.1422	0.2156	-	-
BMI	-0.0027	0.9097	-	-	0.3874	**0.0418**	0.3874	**0.0418**
Number med	0.0414	0.3627	-	-	0.4739	0.1880	-	-

Number med = Total number of medications that participants self-reported they are currently taking
AUC was used to operationalize the construct of impulsivity and associated with impulsivity in the opposite direction

We performed a graphic presentation to test the relationship among three variables: AUC, age, and interaction term (AUC x age) in two dimensions. AUC was plotted on the X axis, with age on the Y axis, and medication adherence score was included as a contour level (Figure 10). The contour levels were plotted as curves, where the colors between curves indicated values. The darker red color, the higher the medication adherence score.

Figure 10: The relationship among age, AUC, and medication adherence score



Non-Response Bias Investigation

Our study had response rate of 18.5%, therefore there is potential for nonresponse bias. This bias might occur when people who did not respond to a survey are different from those who did. To check for this bias, we compared early responders with late responders. Early responders

were defined as the first 150 people who completed the survey, whereas, late responders were defined as the last 150 people who completed the survey. We compared both groups on 8 variables: 4 demographic characteristics (sex, marital status, education level, and household income), AUC, BMI, eating behavior, and physical activity (Table 15). The results showed no statistically significant difference between early responders and late responders on any of these variables. Medication adherence was not tested given the low sample size.

Table 15 Early and late responders on background characteristics, physical activity, AUC, BMI, and eating behavior

Characteristics	Early response N (%) / Mean (SD)	Late response N (%) / Mean (SD)	P
Sex			
• Male	33 (11.07)	41 (13.76)	0.3144
• Female	115 (38.59)	109 (36.58)	
Marital Status			
• Single	32 (10.74)	25 (8.39)	0.4817
• Currently married	95 (31.88)	99 (33.22)	
• Separated, divorced or widowed	21 (7.05)	26 (8.72)	
Education Level			
• Less than high school	0 (0)	0 (0)	0.7192
• High school	6 (2.01)	4 (1.34)	
• Some College	10 (3.36)	15 (5.03)	
• Bachelor's or Associate degree	55 (18.46)	53 (17.79)	
• Graduate or Professional degree	77 (25.84)	78 (26.17)	

Household income • Less than $20,000 per year • $20,000 to 59,999 per year • $60,000 to 99,999 per year • $100,000 to 129,999 per year • $130,000 or more per year	 1 (0.34) 53 (17.97) 48 (16.27) 19 (6.44) 25 (8.47)	 2 (0.68) 50 (16.95) 49 (16.61) 22 (7.46) 26 (8.81)	0.9703
Physical activity • Does not meet the recommendation • Meets the recommendation	 64 (21.99) 84 (28.87)	 66 (22.68) 77 (27.46)	0.6176
AUC	0.3566 (0.23)	0.3656 (0.27)	0.7526
BMI	27.55 (5.82)	28.07 (5.96)	0.4645
Eating behavior	27.21 (6.14)	26.82 (6.38)	0.5936

Continuous variables tested using t-test, categorical variables tested using Chi-square
AUC was used to operationalize the construct of impulsivity and associated with impulsivity in the opposite direction

Chapter 5. Discussion

The purpose of this chapter is to discuss the research findings, to compare the similarity and differences between the research findings and the previous literature, discuss the limitations of this study, and lastly, present the opportunities and suggestions for future research.

This chapter consists of three parts: the first part is the overview of the findings in this study and the discussion of the findings in this study for each hypothesis, the second part is the limitations of this study, and the last part is the conclusion, opportunities and suggestions for future research.

Overview and discussion of the findings

Our study has five hypotheses: impulsivity will have a direct association with diabetes in adults (H1), BMI will be a mediator between level of impulsivity and diabetes in adults (H2), level of impulsivity will have an association with diet behavior in adults (H3), level of impulsivity will have an association with physical activity behavior in adults (H4), and level of impulsivity will have an association with medication adherence in adults with diabetes (H5).

Overall, impulsivity was associated with diet behavior and physical activity, as we hypothesized (H3, and H4). However, impulsivity did not have a direct association with diagnosis of diabetes as we hypothesized (H1) and the second hypothesis was not tested. For the fifth hypothesis, impulsivity had an association with medication adherence measured using the Morisky, but was not with the Medometer (H5), and only in a multivariable model adjusted for age.

For the first hypothesis, the results from the univariable (unadjusted) logistic regressions

and multivariable (adjusted) logistic regressions showed that impulsivity did not have an association with having diabetes. However, other variables such as age and BMI had a positive association with diagnosis of diabetes, which means as age and BMI increased, the odds of having diabetes also increased. These results were consistent with previous studies that age and BMI have been shown to be associated with increased risk of diabetes (82-86). Besides, age and overweight or obesity are risk factors that increase risk for developing diabetes. There are a few possible reasons that can explain why impulsivity did not have an association with having diabetes as we hypothesized. First, our study included a low number of people with diabetes and may not be powered to detect an association. Second, it may have other variables that play roles as mediators between AUC and having diabetes, masking the association between impulsivity and diabetes. Third, being impulsive alone may not be enough to increase a person's risk of developing diabetes.

The second hypothesis was not tested because the association between impulsivity and diabetes was not significant.

The third hypothesis is the level of impulsivity will have an association with diet behavior in adults. Overall, the result of multiple linear regression showed AUC, age, sex, marital status, education were factors that were positively associated with eating behavior and BMI was negatively associated with eating behavior. The results are reasonable that eating behaviors was negatively associated with BMI, which means increased eating behavior score (more healthful eating behaviors) was associated with a decreased BMI. The positive association found between AUC and healthfulness of diet is supported by a previous study that found an increase in frequency of fast-food consumption, which might imply to unhealthy diet, was negatively associated with AUC and positively associated with BMI (77). However, the measure

of diet behavior in that study was the frequency of fast-food consumption, whereas, in our study, a food behavior check list that measures overall diet quality was used to operationalize eating behavior. Further, our results also showed that older people tend to have more heathy eating behaviors than younger people, which could be because, as people get older, they have more knowledge about food and have more income for buying healthy foods. These findings also corresponded with another study that found an increase in healthy diet was positively associated with age and negatively associated with BMI (87). However, impulsivity was not measured in that study. This finding could be because, as people have unhealthy foods that are generally high-calories, they should have high BMI compared with people who have healthy food.

It is reasonable that people with a lower level of impulsivity may give more consideration to their health in the future than people with high levels of impulsivity, leading them to have more healthful eating behaviors. Further, people with greater education may have more knowledge than people with less education, leading them to place a greater emphasis on future health and therefore eat a more healthful diet. In addition, people who are married or divorced may have more people to care for such as their children, making them more concerned about their health compared to those who are single.

The fourth hypothesis is that level of impulsivity will have an association with physical activity behavior in adults. Overall, the results showed AUC, age, and BMI were significant predictors of meeting the physical activity guideline. When AUC increased (impulsivity decreased), odds of having physical activity that meets the recommendation increased. Whereas, as age and BMI increased, odds of having a physical activity that meets the recommendation decreased. These findings are reasonable that older people have less physical activity than younger people. Older people may exercise less as they age due to their physical impairments

that keep them away from participating in certain activities. Further, females had lower odds of meeting the physical activity recommendation compared to males. This finding also corresponds with previous studies that showed that females were less physically active than males and less likely to meet the recommended activity guidelines (88, 89). However, physical activity was not measured by GPAQ in those studies.

The positive association between physical activity and AUC was supported by a previous study that showed people with greater AUC reported engaging in more physical activity (40). However, AUC was divided into two groups, high value of the future and low value of the future, and tested by t-test and physical activity was measured as continuous scores, whereas, in our study, the association was tested by multiple logistic regression and physical activity was dichotomized into "meets" or "does not meet" the recommendation. The negative association between physical activity and age was supported by a previous study that demonstrated that physical activity tended to decrease when age increased (90). However, age was classified into 7 groups: 20-29 years old, 30-39 years old, 40-49 years old, 50-59 years old, 60-69 years old, and 70 years old or older, whereas, in our study, age was measured as a continuous variable. This finding could be because, as people have high physical activity, meets physical activity guideline, they should have low BMI compared with people who have low physical activity.

The last hypothesis is level of impulsivity will have an association with medication adherence in adults with diabetes. Our study showed that AUC, age, and interaction term (AUC x age) were statistically significantly associated with the Morisky medication adherence score. One possible reason is that age may be a confounding variable with both medication adherence and impulsivity. When impulsivity was tested alone (unadjusted model), it was not associated with medication adherence. After controlling for age (adjusted model), which means testing the

effect of impulsivity when age is held constant, impulsivity was associated with medication adherence. However, the Medometer medication adherence score was associated only with BMI. One possible reason that can explain this finding is that these measurements are not measuring exactly the same construct. For example, the Medometer can determine over adherence while Morisky cannot determine it. After removal of participants who reported over adherence from the analysis, the results were the same as before removal. Another possible reason is that Morisky was not highly associated with Medometer. Although the Pearson correlation coefficient between the Morisky medication adherence score and the Medometer medication adherence showed a significant correlation ($r=0.6043$, $p<0.0001$), perhaps they are not highly correlated enough so that the final model results were different in regard to associations with other variables. Our conclusion is based on the Morisky medication adherence, which has demonstrated high reliability and validity (46-48).

Moreover, we performed a test of the relationship among AUC, age, and Morisky medication adherence (Figure 11). The results showed that age or AUC was positively associated with medication adherence in middle-aged adults or young adults. However, these associations became negatively associated with medication adherence in elderly adults. One possible reason is that the delay discounting task may not be suitable for elderly people because they may not consider waiting for 25 years to get a reward. The result of this hypothesis stands alone as the first study to determine the association between impulsivity and adherence to medications for diabetes.

Limitations

Overall, the findings in our study corresponded with previous studies. However, in our study, the measurements or the variables differed from those in other studies. Results of this study should

be interpreted in light of a few limitations. First, our study was cross-sectional and we were unable to determine causality between impulsivity and outcome variables. Further, all measures were based on self-report, introducing the potential for recall bias. Another limitation in our study is the possibility of social desirability bias, such as over-reporting on medication adherence, physical activity, or eating behavior. Our study did not have a way to verify participants' answers because we conducted an online survey in which data were anonymous. We were not able to match our results with patients' prescription data or contact participants to verify their answers. Third, the response rate was relatively low (18.5%), potentially introducing nonresponse bias. However, results of a non-response bias investigation showed no statistically significant difference between early responders and late responders on any variables. This indicates that the non-responder bias may not be a limitation in our study. Further, the relatively low response rate could be explained by the fact that this study was conducted in the summer, a time in which many employees travel and may not have had access to the internet. Another limitation is the medication adherence results may not apply to people who used injectable diabetes medication such as insulin because we did not include these medications on the list from which the participants could choose. Lastly, given the high education level of the study sample (half reported having a graduate degree or higher) the sample may not be representative of the general population, limiting the generalizability of our results.

Conclusion, opportunities, and suggestions for future research

This study is the first study to examine the relationships among impulsivity, diet behavior, physical activity, medication adherence, and diagnosis of diabetes. Our findings indicate no direct association between impulsivity and having diabetes. Moreover, our findings also indicate that impulsivity was associated with diet behavior, physical activity, and medication

adherence. We conclude that lower levels of impulsivity are associated with more favorable diet behavior, greater levels of physical activity, and improved medication adherence.

Previous studies showed that impulsivity is a personality trait and thus is unchanging (91, 92). However, we can incorporate some components to create an intervention helping patients to overcome their inclination toward short-term rewards such as purchasing unhealthy food, such as a reward substitution to incentivize the purchase and consumption of healthy food.

Future studies should focus on the study design and the target population, including an implementation. If clinicians plan to use impulsivity as a screening test in the clinical setting, shorter measures will need to be developed and validated. We believe that these findings provide support for public health to identify individuals who might be at risk for developing diabetes, help people modify their behaviors, and also help people with diabetes achieve the goal of treatment.

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Appendix 1: Study Invitation Email

PURPOSE: The goal of this research is to assess the association between impulsivity, diabetes, eating behavior, physical activity behavior, and medication adherence in adults. This information will shed light on how health care providers can effectively target interventions. This study is being conducted by Thanasak Lertpichitkul, BS in Pharm.

WHAT DO YOU DO?: To participate in this project, you will need to complete an online survey consisting of items related to eating behaviors, physical activity behaviors, diabetes, medication adherence, impulsivity, height, and weight, which can be accessed using the web address below. Anyone 19 years of age or older is eligible.

WHY PARTICIPATE?: Participants who complete the online survey and provide their contact information will have a chance to win one of two $100 cash prizes. The survey will take approximately 15-20 minutes to complete, and can be taken at any time, wherever you have access to the internet.

You were identified as a potential participant by the Healthy Tigers program staff. Your contact information will not be shared with the research team, nor will your decision to decline should you decide not to participate.

For more information, contact: Thanasak Lertpichitkul, BS in Pharm, Master's Degree Student, Health Outcomes Research and Policy, 020 Foy Hall, Auburn, AL 36849,**tzl0022@auburn.edu**

To connect to the survey directly, go to https://auburn.qualtrics.com/SE/?SID=SV_819gbQ3ywc2fH1P

The Auburn University Institutional Review Board has approved this document for use from May 20, 2015 to May 19, 2016. Protocol #15-199 EP 1505.

Appendix 2 Survey Questionnaire

Introduction

Consent to Participate

You are invited to participate in a research study to test the association between impulsivity, diabetes, eating behaviors, physical activity behaviors, and medication adherence. This study is being conducted by Thanasak Lertpichitkul, a Master's degree student of Health Outcomes Research and Policy. The purpose of the study is to shed light on effective communication techniques that pharmacists and other health care providers can use when talking to their patients about diabetes prevention and treatment.

We would appreciate your help in this study by answering the questions in this survey, which consist of items related to eating behaviors, physical activity behaviors, diabetes, medication adherence, impulsivity, height, and weight. Completing the questionnaire will take approximately 15-20 minutes. The survey must be completed in one sitting; you cannot exit and return to the survey once you've begun. There are no known risks or direct benefits from participating in this study. Although there are no sensitive questions or questions that are likely to cause discomfort, you may elect to quit at any time without penalty. Participation in this study is voluntary and in no way will affect your class standing, grades, or status on an athletic team if you are a student at Auburn University, or job standing if you are an employee of Auburn University.

To compensate you for your time, if you complete all of the questions in the survey and provide your contact information, you will be entered in a drawing for a chance to win one of two $100 cash prizes. Chances of winning are approximately one in 500. Contact information will be collected in a separate database and will not be linked to your responses to the survey.

Information obtained from this study may be published in a professional journal, presented at professional meetings, departmental and school-wide seminars, and/or University-wide research forums. If so, only group data will be presented.

If you have any questions about this study contact Thanasak Lertpichitkul, BS in Pharm at 334-844-5152. For more information regarding your rights as a research participant, you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone at (334) 844-5966 or e-mail at hsubjec@auburn.edu or IRBChair@auburn.edu.

HAVING READ THE INFORMATION PROVIDED YOU MUST DECIDE WHETHER OR NOT YOU WISH TO PARTICIPATE IN THIS RESEARCH PROJECT. YOUR COMPLETION OF THE ON-LINE SURVEY INDICATES YOUR WILLINGNESS TO PARTICIPATE. The Auburn University Institutional Review Board has approved this document for use from May 20, 2015 to May 19, 2016. Protocol # 15-199 EP 1505.

By choosing "I accept" you acknowledge that you have read and understand the information given above, and agree to proceed with the questionnaire.

- ○ I accept
- ○ I do not wish to continue

Eligibility

Are you 19 years of age or older?

- ○ Yes
- ○ No

Food Behavior Checklist

These questions are about the ways you plan and fix food.
Think about how you usually do things.

Do you eat fruits or vegetables as snacks?

No	Yes, sometimes	Yes, often	Yes, everyday
○	○	○	○

Do you drink fruit drinks, sport drinks or punch?

No	Yes, sometimes	Yes, often	Yes, everyday
○	○	○	○

Do you drink regular soda?

No	Yes, sometimes	Yes, often	Yes, everyday
○	○	○	○

Do you drink milk *(include cow, goat, almond, soy, and rice milk)*?

No	Yes, sometimes	Yes, often	Yes, everyday
○	○	○	○

Did you drink milk or use milk (include cow, goat, almond, soy, and rice milk) on cereal during the past week?

Yes ○ No ○

Did you have citrus fruit or citrus juice during the past week?

Yes ○ No ○

Fruit 1 serving is...

Apple: 1 small apple (about 2 ½ inches in diameter)

Peach: 1 large peach (about the size of tennis ball)

Banana: 1 large banana (8 to 9 inches long)

Strawberry: 8 large berries

How many servings of fruit do you eat each day?

Do you eat more than one kind of **fruit** each day?

No ○ Yes, sometimes ○ Yes, often ○ Yes, always ○

Do you eat more than one kind of **vegetable** each day?

No	Yes, sometimes	Yes, often	Yes, always
○	○	○	○

Vegetables 1 serving is...

Asparagus: about 4 spears

Celery: 1 cup dices or 2 stalks (11 to 12 inches long)

Broccoli: 16 small florets (tennis ball size)

Green beans: 1 cup (about 10 beans)

How many servings of vegetables do you eat each day?

Do you take the skin off chicken?

No	Yes, sometimes	Yes, often	Yes, always	I don't eat chicken
○	○	○	○	○

Did you have fish during the past week?

Yes	No
○	○

Do you eat 2 or more different types of vegetables at your main meal?

No	Yes, sometimes	Yes, often	Yes, everyday
○	○	○	○

Do you use this label when food shopping?

No	Yes, sometimes	Yes, often	Yes, always
○	○	○	○

Do you run out of food before the end of the month?

No	Yes, sometimes	Yes, often	Yes, always
○	○	○	○

How would you rate your eating habits?

	Poor	2	3	Fair	5	6	Good	8	9	Excellent
	○	○	○	○	○	○	○	○	○	○

Physical activity

Think first about the time you spend doing work. Think of work as the things that you have to do such as paid or unpaid work, study/training, household chores, harvesting food/crops, fishing or hunting for food, seeking employment in answering the following questions.

Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate for at least 10 minutes continuously? [Example: carrying or lifting heavy loads, digging or construction work]

('Vigorous-intensity activities are activities that require hard physical effort and cause large increases in breathing or heart rate.)

- ○ Yes
- ○ No

In a typical week, on how many days do you do vigorous intensity activities as part of your work?

How much time (in hours and minutes) do you spend doing vigorous-intensity activities at work on a typical day?

Hours

Minutes

Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking or carrying light loads for at least 10 minutes continuously?

('Moderate-intensity activities are activities that require moderate physical effort and cause small increases in breathing or heart rate.)

- ○ Yes
- ○ No

In a typical week, on how many days do you do moderate intensity activities as part of your work?

How much time (in hours and minutes) do you spend doing moderate-intensity activities at work on a typical day?

Hours

Minutes

Now I would like to ask you about the usual way you travel to and from places.
For example to work, for shopping, to market, to place of worship.

Do you walk or use a bicycle for at least 10 minutes continuously to get to and from places?

- Yes
- No

In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?

How much time (in hours and minutes) do you spend walking or bicycling for travel on a typical day?

Hours

Minutes

The next questions exclude the work and transport activities that you have already mentioned.
Now I would like to ask you about sports, fitness and recreational activities (leisure).

Do you do any vigorous-intensity sports, fitness or recreational (leisure) activities that cause large increases in breathing or heart rate for at least 10 minutes continuously? [Example: running or football]

('Vigorous-intensity activities are activities that require hard physical effort and cause large increases in breathing or heart rate.)

- ○ Yes
- ○ No

In a typical week, on how many days do you do vigorous intensity sports, fitness or recreational (leisure) activities?

How much time (in hours and minutes) do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?

Hours

Minutes

Do you do any moderate-intensity sports, fitness or recreational (leisure) activities that causes a small increase in breathing or heart rate such as brisk walking, cycling, swimming, or volleyball for at least 10 minutes continuously?

('Moderate-intensity activities are activities that require moderate physical effort and cause small increases in breathing or heart rate.)

- ○ Yes
- ○ No

In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational (leisure) activities?

How much time (in hours and minutes) do you spend doing moderate-intensity sports, fitness or recreational (leisure) activities on a typical day?

Hours

Minutes

The following question is about sitting or reclining at work, at home, with friends (including sitting at a desk, sitting with friends, reading, playing cards, playing video games, watching television, etc.) or while traveling to and from places (automobile, bus, transit, etc.) but does not include time spent sleeping.

How much time (in hours and minutes) do you usually spend sitting or reclining on a typical day?

Hours

Minutes

Introduction and Instruction

The next set of questions involves making choices between two imaginary rewards, in terms of money received now or sometime in the future.

For each item, you will be given two choices. They will have different dollar values. One choice will be to receive a smaller dollar amount now; the other will be to receive a larger dollar amount in the future. Imagine that you are given the option to choose one or the other, and select the one you prefer.

Keep in mind that the rewards are imaginary and you will not actually receive them. Be sure to read each choice very carefully, as the amount of the rewards and length of the delay will vary. For each item, select the choice that you prefer. You cannot change your answer once you have clicked the "Next" button.

Delay = 1 day

Imagine that you have a choice between two dollar amounts: one you would receive NOW and one you would receive ONE DAY FROM NOW. Which of the following would you prefer?

- ○ $500 now
- ○ $1000 one day from now

Which would you prefer?

○

- $250 now
- $1000 one day from now

Which would you prefer?

- $750 now
- $1000 one day from now

Which would you prefer?

- $125 now
- $1000 one day from now

Which would you prefer?

- $375 now
- $1000 one day from now

Which would you prefer?

- $625 now
- $1000 one day from now

Which would you prefer?

- $875 now
- $1000 one day from now

Which would you prefer?

- $62.50 now
- $1000 one day from now

Which would you prefer?

- $187.50 now
- $1000 one day from now

Which would you prefer?

- $312.50 now
- $1000 one day from now

Which would you prefer?

- $437.50 now
- $1000 one day from now

Which would you prefer?

- $562.50 now
- $1000 one day from now

Which would you prefer?

- $687.50 now
- $1000 one day from now

Which would you prefer?

- $812.50 now
- $1000 one day from now

Which would you prefer?

- $937.50 now
- $1000 one day from now

Which would you prefer?

- $31.25 now
- $1000 one day from now

Which would you prefer?

- $93.75 now
- $1000 one day from now

Which would you prefer?

- $156.25 now
- $1000 one day from now

Which would you prefer?

- $218.75 now
- $1000 one day from now

Which would you prefer?

- $281.25 now
- $1000 one day from now

Which would you prefer?

-

$343.75 now

- ○ $1000 one day from now

Which would you prefer?

- ○ $406.25 now
- ○ $1000 one day from now

Which would you prefer?

- ○ $468.75 now
- ○ $1000 one day from now

Which would you prefer?

- ○ $531.25 now
- ○ $1000 one day from now

Which would you prefer?

- ○ $593.75 now
- ○ $1000 one day from now

Which would you prefer?

- ○ $656.25 now
- ○ $1000 one day from now

Which would you prefer?

- ○ $718.75 now
- ○ $1000 one day from now

Which would you prefer?

- $781.25 now
- $1000 one day from now

Which would you prefer?

- $843.75 now
- $1000 one day from now

Which would you prefer?

- $906.25 now
- $1000 one day from now

Which would you prefer?

- $968.75 now
- $1000 one day from now

Which would you prefer?

- $15.62 now
- $1000 one day from now

Which would you prefer?

- $46.87 now
- $1000 one day from now

Which would you prefer?

- $78.12 now
- $1000 one day from now

Which would you prefer?

- $109.37 now
- $1000 one day from now

Which would you prefer?

- $140.62 now
- $1000 one day from now

Which would you prefer?

- $171.87 now
- $1000 one day from now

Which would you prefer?

- $203.12 now
- $1000 one day from now

Which would you prefer?

- $234.37 now
- $1000 one day from now

Which would you prefer?

$265.62 now

- ○ $1000 one day from now

Which would you prefer?

- ○ $296.87 now
- ○ $1000 one day from now

Which would you prefer?

- ○ $328.12 now
- ○ $1000 one day from now

Which would you prefer?

- ○ $359.37 now
- ○ $1000 one day from now

Which would you prefer?

- ○ $390.62 now
- ○ $1000 one day from now

Which would you prefer?

- ○ $421.87 now
- ○ $1000 one day from now

Which would you prefer?

- ○ $453.12 now
- ○ $1000 one day from now

Which would you prefer?

- $484.37 now
- $1000 one day from now

Which would you prefer?

- $515.62 now
- $1000 one day from now

Which would you prefer?

- $546.87 now
- $1000 one day from now

Which would you prefer?

- $578.12 now
- $1000 one day from now

Which would you prefer?

- $609.37 now
- $1000 one day from now

Which would you prefer?

- $640.62 now
- $1000 one day from now

Which would you prefer?

- $671.87 now
- $1000 one day from now

Which would you prefer?

- $703.12 now
- $1000 one day from now

Which would you prefer?

- $734.37 now
- $1000 one day from now

Which would you prefer?

- $765.62 now
- $1000 one day from now

Which would you prefer?

- $796.87 now
- $1000 one day from now

Which would you prefer?

- $828.12 now
- $1000 one day from now

Which would you prefer?

$859.37 now

- ◯ $1000 one day from now

Which would you prefer?

- ◯ $890.62 now
- ◯ $1000 one day from now

Which would you prefer?

- ◯ $921.87 now
- ◯ $1000 one day from now

Which would you prefer?

- ◯ $953.12 now
- ◯ $1000 one day from now

Which would you prefer?

- ◯ $984.37 now
- ◯ $1000 one day from now

Delay = 1 week

Imagine that you have a choice between two dollar amounts: one you would receive NOW and one you would receive ONE WEEK FROM NOW. Which of the following would you prefer?

- ◯ $500 now
- ◯ $1000 one week from now

Which would you prefer?

- ○ $250 now
- ○ $1000 one week from now

Which would you prefer?

- ○ $750 now
- ○ $1000 one week from now

Which would you prefer?

- ○ $125 now
- ○ $1000 one week from now

Which would you prefer?

- ○ $375 now
- ○ $1000 one week from now

Which would you prefer?

- ○ $625 now
- ○ $1000 one week from now

Which would you prefer?

- ○ $875 now
- ○ $1000 one week from now

Which would you prefer?

- ○ $62.50 now
- ○ $1000 one week from now

Which would you prefer?

- $187.50 now
- $1000 one week from now

Which would you prefer?

- $312.50 now
- $1000 one week from now

Which would you prefer?

- $437.50 now
- $1000 one week from now

Which would you prefer?

- $562.50 now
- $1000 one week from now

Which would you prefer?

- $687.50 now
- $1000 one week from now

Which would you prefer?

- $812.50 now
- $1000 one week from now

Which would you prefer?

- $937.50 now
- $1000 one week from now

Which would you prefer?

- $31.25 now
- $1000 one week from now

Which would you prefer?

- $93.75 now
- $1000 one week from now

Which would you prefer?

- $156.25 now
- $1000 one week from now

Which would you prefer?

- $218.75 now
- $1000 one week from now

Which would you prefer?

- $281.25 now
- $1000 one week from now

Which would you prefer?

- $343.75 now
- $1000 one week from now

Which would you prefer?

- $406.25 now
- $1000 one week from now

Which would you prefer?

- $468.75 now
- $1000 one week from now

Which would you prefer?

- $531.25 now
- $1000 one week from now

Which would you prefer?

- $593.75 now
- $1000 one week from now

Which would you prefer?

- $656.25 now
- $1000 one week from now

Which would you prefer?

- $718.75 now
- $1000 one week from now

Which would you prefer?

- $781.25 now
- $1000 one week from now

Which would you prefer?

- $843.75 now
- $1000 one week from now

Which would you prefer?

- $906.25 now
- $1000 one week from now

Which would you prefer?

- $968.75 now
- $1000 one week from now

Which would you prefer?

- $15.62 now
- $1000 one week from now

Which would you prefer?

- $46.87 now
- $1000 one week from now

Which would you prefer?

- $78.12 now
- $1000 one week from now

Which would you prefer?

- $109.37 now
- $1000 one week from now

Which would you prefer?

- $140.62 now
- $1000 one week from now

Which would you prefer?

- $171.87 now
- $1000 one week from now

Which would you prefer?

- $203.12 now
- $1000 one week from now

Which would you prefer?

- $234.37 now
- $1000 one week from now

Which would you prefer?

-

$265.62 now

- ○ $1000 one week from now

Which would you prefer?

- ○ $296.87 now
- ○ $1000 one week from now

Which would you prefer?

- ○ $328.12 now
- ○ $1000 one week from now

Which would you prefer?

- ○ $359.37 now
- ○ $1000 one week from now

Which would you prefer?

- ○ $390.62 now
- ○ $1000 one week from now

Which would you prefer?

- ○ $421.87 now
- ○ $1000 one week from now

Which would you prefer?

- ○ $453.12 now
- ○ $1000 one week from now

Which would you prefer?

- $484.37 now
- $1000 one week from now

Which would you prefer?

- $515.62 now
- $1000 one week from now

Which would you prefer?

- $546.87 now
- $1000 one week from now

Which would you prefer?

- $578.12 now
- $1000 one week from now

Which would you prefer?

- $609.37 now
- $1000 one week from now

Which would you prefer?

- $640.62 now
- $1000 one week from now

Which would you prefer?

- $671.87 now
- $1000 one week from now

Which would you prefer?

- $703.12 now
- $1000 one week from now

Which would you prefer?

- $734.37 now
- $1000 one week from now

Which would you prefer?

- $765.62 now
- $1000 one week from now

Which would you prefer?

- $796.87 now
- $1000 one week from now

Which would you prefer?

- $828.12 now
- $1000 one week from now

Which would you prefer?

$859.37 now

- ◯ $1000 one week from now

Which would you prefer?

- ◯ $890.62 now
- ◯ $1000 one week from now

Which would you prefer?

- ◯ $921.87 now
- ◯ $1000 one week from now

Which would you prefer?

- ◯ $953.12 now
- ◯ $1000 one week from now

Which would you prefer?

- ◯ $984.37 now
- ◯ $1000 one week from now

Delay - 1 month

Imagine that you have a choice between two dollar amounts: one you would receive NOW and one you would receive ONE MONTH FROM NOW. Which of the following would you prefer?

- ◯ $500 now
- ◯ $1000 one month from now

Which would you prefer?

- ○ $250 now
- ○ $1000 one month from now

Which would you prefer?

- ○ $750 now
- ○ $1000 one month from now

Which would you prefer?

- ○ $125 now
- ○ $1000 one month from now

Which would you prefer?

- ○ $375 now
- ○ $1000 one month from now

Which would you prefer?

- ○ $625 now
- ○ $1000 one month from now

Which would you prefer?

- ○ $875 now
- ○ $1000 one month from now

Which would you prefer?

- ○ $62.50 now
- ○ $1000 one month from now

Which would you prefer?

- $187.50 now
- $1000 one month from now

Which would you prefer?

- $312.50 now
- $1000 one month from now

Which would you prefer?

- $437.50 now
- $1000 one month from now

Which would you prefer?

- $562.50 now
- $1000 one month from now

Which would you prefer?

- $687.50 now
- $1000 one month from now

Which would you prefer?

- $812.50 now
- $1000 one month from now

Which would you prefer?

- $937.50 now
- $1000 one month from now

Which would you prefer?

- $31.25 now
- $1000 one month from now

Which would you prefer?

- $93.75 now
- $1000 one month from now

Which would you prefer?

- $156.25 now
- $1000 one month from now

Which would you prefer?

- $218.75 now
- $1000 one month from now

Which would you prefer?

- $281.25 now
- $1000 one month from now

Which would you prefer?

- $343.75 now
- $1000 one month from now

Which would you prefer?

- $406.25 now
- $1000 one month from now

Which would you prefer?

- $468.75 now
- $1000 one month from now

Which would you prefer?

- $531.25 now
- $1000 one month from now

Which would you prefer?

- $593.75 now
- $1000 one month from now

Which would you prefer?

- $656.25 now
- $1000 one month from now

Which would you prefer?

- $718.75 now
- $1000 one month from now

Which would you prefer?

- $781.25 now
- $1000 one month from now

Which would you prefer?

- $843.75 now
- $1000 one month from now

Which would you prefer?

- $906.25 now
- $1000 one month from now

Which would you prefer?

- $968.75 now
- $1000 one month from now

Which would you prefer?

- $15.62 now
- $1000 one month from now

Which would you prefer?

- $46.87 now
- $1000 one month from now

Which would you prefer?

- $78.12 now
- $1000 one month from now

Which would you prefer?

- $109.37 now
- $1000 one month from now

Which would you prefer?

- $140.62 now
- $1000 one month from now

Which would you prefer?

- $171.87 now
- $1000 one month from now

Which would you prefer?

- $203.12 now
- $1000 one month from now

Which would you prefer?

- $234.37 now
- $1000 one month from now

Which would you prefer?

-

$265.62 now

- ○ $1000 one month from now

Which would you prefer?

- ○ $296.87 now
- ○ $1000 one month from now

Which would you prefer?

- ○ $328.12 now
- ○ $1000 one month from now

Which would you prefer?

- ○ $359.37 now
- ○ $1000 one month from now

Which would you prefer?

- ○ $390.62 now
- ○ $1000 one month from now

Which would you prefer?

- ○ $421.87 now
- ○ $1000 one month from now

Which would you prefer?

- ○ $453.12 now
- ○ $1000 one month from now

Which would you prefer?

- $484.37 now
- $1000 one month from now

Which would you prefer?

- $515.62 now
- $1000 one month from now

Which would you prefer?

- $546.87 now
- $1000 one month from now

Which would you prefer?

- $578.12 now
- $1000 one month from now

Which would you prefer?

- $609.37 now
- $1000 one month from now

Which would you prefer?

- $640.62 now
- $1000 one month from now

Which would you prefer?

- $671.87 now
- $1000 one month from now

Which would you prefer?

- $703.12 now
- $1000 one month from now

Which would you prefer?

- $734.37 now
- $1000 one month from now

Which would you prefer?

- $765.62 now
- $1000 one month from now

Which would you prefer?

- $796.87 now
- $1000 one month from now

Which would you prefer?

- $828.12 now
- $1000 one month from now

Which would you prefer?

$859.37 now

- $1000 one month from now

Which would you prefer?

- $890.62 now
- $1000 one month from now

Which would you prefer?

- $921.87 now
- $1000 one month from now

Which would you prefer?

- $953.12 now
- $1000 one month from now

Which would you prefer?

- $984.37 now
- $1000 one month from now

Delay = 6 months

Imagine that you have a choice between two dollar amounts: one you would receive NOW and one you would receive SIX MONTHS FROM NOW. Which of the following would you prefer?

- $500 now
- $1000 six months from now

Which would you prefer?

- $250 now
- $1000 six months from now

Which would you prefer?

- $750 now
- $1000 six months from now

Which would you prefer?

- $125 now
- $1000 six months from now

Which would you prefer?

- $375 now
- $1000 six months from now

Which would you prefer?

- $625 now
- $1000 six months from now

Which would you prefer?

- $875 now
- $1000 six months from now

Which would you prefer?

- $62.50 now
- $1000 six months from now

Which would you prefer?

- $187.50 now
- $1000 six months from now

Which would you prefer?

- $312.50 now
- $1000 six months from now

Which would you prefer?

- $437.50 now
- $1000 six months from now

Which would you prefer?

- $562.50 now
- $1000 six months from now

Which would you prefer?

- $687.50 now
- $1000 six months from now

Which would you prefer?

- $812.50 now
- $1000 six months from now

Which would you prefer?

- $937.50 now
- $1000 six months from now

Which would you prefer?

- $31.25 now
- $1000 six months from now

Which would you prefer?

- $93.75 now
- $1000 six months from now

Which would you prefer?

- $156.25 now
- $1000 six months from now

Which would you prefer?

- $218.75 now
- $1000 six months from now

Which would you prefer?

- $281.25 now
- $1000 six months from now

Which would you prefer?

- $343.75 now
- $1000 six months from now

Which would you prefer?

- $406.25 now
- $1000 six months from now

Which would you prefer?

- $468.75 now
- $1000 six months from now

Which would you prefer?

- $531.25 now
- $1000 six months from now

Which would you prefer?

- $593.75 now
- $1000 six months from now

Which would you prefer?

- $656.25 now
- $1000 six months from now

Which would you prefer?

- $718.75 now
- $1000 six months from now

Which would you prefer?

- $781.25 now
- $1000 six months from now

Which would you prefer?

- $843.75 now
- $1000 six months from now

Which would you prefer?

- $906.25 now
- $1000 six months from now

Which would you prefer?

- $968.75 now
- $1000 six months from now

Which would you prefer?

- $15.62 now
- $1000 six months from now

Which would you prefer?

- $46.87 now
- $1000 six months from now

Which would you prefer?

- $78.12 now
- $1000 six months from now

Which would you prefer?

- $109.37 now
- $1000 six months from now

Which would you prefer?

- $140.62 now
- $1000 six months from now

Which would you prefer?

- $171.87 now
- $1000 six months from now

Which would you prefer?

- $203.12 now
- $1000 six months from now

Which would you prefer?

- $234.37 now
- $1000 six months from now

Which would you prefer?

$265.62 now

- ○ $1000 six months from now

Which would you prefer?

- ○ $296.87 now
- ○ $1000 six months from now

Which would you prefer?

- ○ $328.12 now
- ○ $1000 six months from now

Which would you prefer?

- ○ $359.37 now
- ○ $1000 six months from now

Which would you prefer?

- ○ $390.62 now
- ○ $1000 six months from now

Which would you prefer?

- ○ $421.87 now
- ○ $1000 six months from now

Which would you prefer?

- ○ $453.12 now
- ○ $1000 six months from now

Which would you prefer?

- $484.37 now
- $1000 six months from now

Which would you prefer?

- $515.62 now
- $1000 six months from now

Which would you prefer?

- $546.87 now
- $1000 six months from now

Which would you prefer?

- $578.12 now
- $1000 six months from now

Which would you prefer?

- $609.37 now
- $1000 six months from now

Which would you prefer?

- $640.62 now
- $1000 six months from now

Which would you prefer?

- $671.87 now
- $1000 six months from now

Which would you prefer?

- $703.12 now
- $1000 six months from now

Which would you prefer?

- $734.37 now
- $1000 six months from now

Which would you prefer?

- $765.62 now
- $1000 six months from now

Which would you prefer?

- $796.87 now
- $1000 six months from now

Which would you prefer?

- $828.12 now
- $1000 six months from now

Which would you prefer?

$859.37 now

- $1000 six months from now

Which would you prefer?

- $890.62 now
- $1000 six months from now

Which would you prefer?

- $921.87 now
- $1000 six months from now

Which would you prefer?

- $953.12 now
- $1000 six months from now

Which would you prefer?

- $984.37 now
- $1000 six months from now

Delay = 1 year

Imagine that you have a choice between two dollar amounts: one you would receive NOW and one you would receive ONE YEAR FROM NOW. Which of the following would you prefer?

- $500 now
- $1000 one year from now

Which would you prefer?

- $250 now
- $1000 one year from now

Which would you prefer?

- $750 now
- $1000 one year from now

Which would you prefer?

- $125 now
- $1000 one year from now

Which would you prefer?

- $375 now
- $1000 one year from now

Which would you prefer?

- $625 now
- $1000 one year from now

Which would you prefer?

- $875 now
- $1000 one year from now

Which would you prefer?

- $62.50 now
- $1000 one year from now

Which would you prefer?

- $187.50 now
- $1000 one year from now

Which would you prefer?

- $312.50 now
- $1000 one year from now

Which would you prefer?

- $437.50 now
- $1000 one year from now

Which would you prefer?

- $562.50 now
- $1000 one year from now

Which would you prefer?

- $687.50 now
- $1000 one year from now

Which would you prefer?

- $812.50 now
- $1000 one year from now

Which would you prefer?

- $937.50 now
- $1000 one year from now

Which would you prefer?

- $31.25 now
- $1000 one year from now

Which would you prefer?

- $93.75 now
- $1000 one year from now

Which would you prefer?

- $156.25 now
- $1000 one year from now

Which would you prefer?

- $218.75 now
- $1000 one year from now

Which would you prefer?

- $281.25 now
- $1000 one year from now

Which would you prefer?

- $343.75 now
- $1000 one year from now

Which would you prefer?

- $406.25 now
- $1000 one year from now

Which would you prefer?

- $468.75 now
- $1000 one year from now

Which would you prefer?

- $531.25 now
- $1000 one year from now

Which would you prefer?

- $593.75 now
- $1000 one year from now

Which would you prefer?

- $656.25 now
- $1000 one year from now

Which would you prefer?

- $718.75 now
- $1000 one year from now

Which would you prefer?

- $781.25 now
- $1000 one year from now

Which would you prefer?

- $843.75 now
- $1000 one year from now

Which would you prefer?

- $906.25 now
- $1000 one year from now

Which would you prefer?

- $968.75 now
- $1000 one year from now

Which would you prefer?

- $15.62 now
- $1000 one year from now

Which would you prefer?

- $46.87 now
- $1000 one year from now

Which would you prefer?

- $78.12 now
- $1000 one year from now

Which would you prefer?

- $109.37 now
- $1000 one year from now

Which would you prefer?

- $140.62 now
- $1000 one year from now

Which would you prefer?

- $171.87 now
- $1000 one year from now

Which would you prefer?

- $203.12 now
- $1000 one year from now

Which would you prefer?

- $234.37 now
- $1000 one year from now

Which would you prefer?

-

$265.62 now

- ○ $1000 one year from now

Which would you prefer?

- ○ $296.87 now
- ○ $1000 one year from now

Which would you prefer?

- ○ $328.12 now
- ○ $1000 one year from now

Which would you prefer?

- ○ $359.37 now
- ○ $1000 one year from now

Which would you prefer?

- ○ $390.62 now
- ○ $1000 one year from now

Which would you prefer?

- ○ $421.87 now
- ○ $1000 one year from now

Which would you prefer?

- ○ $453.12 now
- ○ $1000 one year from now

Which would you prefer?

- $484.37 now
- $1000 one year from now

Which would you prefer?

- $515.62 now
- $1000 one year from now

Which would you prefer?

- $546.87 now
- $1000 one year from now

Which would you prefer?

- $578.12 now
- $1000 one year from now

Which would you prefer?

- $609.37 now
- $1000 one year from now

Which would you prefer?

- $640.62 now
- $1000 one year from now

Which would you prefer?

- $671.87 now
- $1000 one year from now

Which would you prefer?

- $703.12 now
- $1000 one year from now

Which would you prefer?

- $734.37 now
- $1000 one year from now

Which would you prefer?

- $765.62 now
- $1000 one year from now

Which would you prefer?

- $796.87 now
- $1000 one year from now

Which would you prefer?

- $828.12 now
- $1000 one year from now

Which would you prefer?

$859.37 now

- $1000 one year from now

Which would you prefer?

- $890.62 now
- $1000 one year from now

Which would you prefer?

- $921.87 now
- $1000 one year from now

Which would you prefer?

- $953.12 now
- $1000 one year from now

Which would you prefer?

- $984.37 now
- $1000 one year from now

Delay = 5 years

Imagine that you have a choice between two dollar amounts: one you would receive NOW and one you would receive FIVE YEARS FROM NOW. Which of the following would you prefer?

- $500 now
- $1000 five years from now

Which would you prefer?

- ○ $250 now
- ○ $1000 five years from now

Which would you prefer?

- ○ $750 now
- ○ $1000 five years from now

Which would you prefer?

- ○ $125 now
- ○ $1000 five years from now

Which would you prefer?

- ○ $375 now
- ○ $1000 five years from now

Which would you prefer?

- ○ $625 now
- ○ $1000 five years from now

Which would you prefer?

- ○ $875 now
- ○ $1000 five years from now

Which would you prefer?

- ○ $62.50 now
- ○ $1000 five years from now

Which would you prefer?

- $187.50 now
- $1000 five years from now

Which would you prefer?

- $312.50 now
- $1000 five years from now

Which would you prefer?

- $437.50 now
- $1000 five years from now

Which would you prefer?

- $562.50 now
- $1000 five years from now

Which would you prefer?

- $687.50 now
- $1000 five years from now

Which would you prefer?

- $812.50 now
- $1000 five years from now

Which would you prefer?

- $937.50 now
- $1000 five years from now

Which would you prefer?

- $31.25 now
- $1000 five years from now

Which would you prefer?

- $93.75 now
- $1000 five years from now

Which would you prefer?

- $156.25 now
- $1000 five years from now

Which would you prefer?

- $218.75 now
- $1000 five years from now

Which would you prefer?

- $281.25 now
- $1000 five years from now

Which would you prefer?

- $343.75 now
- $1000 five years from now

Which would you prefer?

- $406.25 now
- $1000 five years from now

Which would you prefer?

- $468.75 now
- $1000 five years from now

Which would you prefer?

- $531.25 now
- $1000 five years from now

Which would you prefer?

- $593.75 now
- $1000 five years from now

Which would you prefer?

- $656.25 now
- $1000 five years from now

Which would you prefer?

- $718.75 now
- $1000 five years from now

Which would you prefer?

- $781.25 now
- $1000 five years from now

Which would you prefer?

- $843.75 now
- $1000 five years from now

Which would you prefer?

- $906.25 now
- $1000 five years from now

Which would you prefer?

- $968.75 now
- $1000 five years from now

Which would you prefer?

- $15.62 now
- $1000 five years from now

Which would you prefer?

- $46.87 now
- $1000 five years from now

Which would you prefer?

- $78.12 now
- $1000 five years from now

Which would you prefer?

- $109.37 now
- $1000 five years from now

Which would you prefer?

- $140.62 now
- $1000 five years from now

Which would you prefer?

- $171.87 now
- $1000 five years from now

Which would you prefer?

- $203.12 now
- $1000 five years from now

Which would you prefer?

- $234.37 now
- $1000 five years from now

Which would you prefer?

$265.62 now

- ○ $1000 five years from now

Which would you prefer?

- ○ $296.87 now
- ○ $1000 five years from now

Which would you prefer?

- ○ $328.12 now
- ○ $1000 five years from now

Which would you prefer?

- ○ $359.37 now
- ○ $1000 five years from now

Which would you prefer?

- ○ $390.62 now
- ○ $1000 five years from now

Which would you prefer?

- ○ $421.87 now
- ○ $1000 five years from now

Which would you prefer?

- ○ $453.12 now
- ○ $1000 five years from now

Which would you prefer?

- $484.37 now
- $1000 five years from now

Which would you prefer?

- $515.62 now
- $1000 five years from now

Which would you prefer?

- $546.87 now
- $1000 five years from now

Which would you prefer?

- $578.12 now
- $1000 five years from now

Which would you prefer?

- $609.37 now
- $1000 five years from now

Which would you prefer?

- $640.62 now
- $1000 five years from now

Which would you prefer?

- $671.87 now
- $1000 five years from now

Which would you prefer?

- $703.12 now
- $1000 five years from now

Which would you prefer?

- $734.37 now
- $1000 five years from now

Which would you prefer?

- $765.62 now
- $1000 five years from now

Which would you prefer?

- $796.87 now
- $1000 five years from now

Which would you prefer?

- $828.12 now
- $1000 five years from now

Which would you prefer?

$859.37 now

- ○ $1000 five years from now

Which would you prefer?

- ○ $890.62 now
- ○ $1000 five years from now

Which would you prefer?

- ○ $921.87 now
- ○ $1000 five years from now

Which would you prefer?

- ○ $953.12 now
- ○ $1000 five years from now

Which would you prefer?

- ○ $984.37 now
- ○ $1000 five years from now

Delay = 25 years

Imagine that you have a choice between two dollar amounts: one you would receive NOW and one you would receive TWENTY-FIVE YEARS FROM NOW. Which of the following would you prefer?

- ○ $500 now
- ○ $1000 twenty-five years from now

Which would you prefer?

- ○ $250 now
- ○ $1000 twenty-five years from now

Which would you prefer?

- ○ $750 now
- ○ $1000 twenty-five years from now

Which would you prefer?

- ○ $125 now
- ○ $1000 twenty-five years from now

Which would you prefer?

- ○ $375 now
- ○ $1000 twenty-five years from now

Which would you prefer?

- ○ $625 now
- ○ $1000 twenty-five years from now

Which would you prefer?

- ○ $875 now
- ○ $1000 twenty-five years from now

Which would you prefer?

- ○ $62.50 now
- ○ $1000 twenty-five years from now

Which would you prefer?

- $187.50 now
- $1000 twenty-five years from now

Which would you prefer?

- $312.50 now
- $1000 twenty-five years from now

Which would you prefer?

- $437.50 now
- $1000 twenty-five years from now

Which would you prefer?

- $562.50 now
- $1000 twenty-five years from now

Which would you prefer?

- $687.50 now
- $1000 twenty-five years from now

Which would you prefer?

- $812.50 now
- $1000 twenty-five years from now

Which would you prefer?

- $937.50 now
- $1000 twenty-five years from now

Which would you prefer?

- $31.25 now
- $1000 twenty-five years from now

Which would you prefer?

- $93.75 now
- $1000 twenty-five years from now

Which would you prefer?

- $156.25 now
- $1000 twenty-five years from now

Which would you prefer?

- $218.75 now
- $1000 twenty-five years from now

Which would you prefer?

- $281.25 now
- $1000 twenty-five years from now

Which would you prefer?

- $343.75 now
- $1000 twenty-five years from now

Which would you prefer?

- $406.25 now
- $1000 twenty-five years from now

Which would you prefer?

- $468.75 now
- $1000 twenty-five years from now

Which would you prefer?

- $531.25 now
- $1000 twenty-five years from now

Which would you prefer?

- $593.75 now
- $1000 twenty-five years from now

Which would you prefer?

- $656.25 now
- $1000 twenty-five years from now

Which would you prefer?

- $718.75 now
- $1000 twenty-five years from now

Which would you prefer?

- $781.25 now
- $1000 twenty-five years from now

Which would you prefer?

- $843.75 now
- $1000 twenty-five years from now

Which would you prefer?

- $906.25 now
- $1000 twenty-five years from now

Which would you prefer?

- $968.75 now
- $1000 twenty-five years from now

Which would you prefer?

- $15.62 now
- $1000 twenty-five years from now

Which would you prefer?

- $46.87 now
- $1000 twenty-five years from now

Which would you prefer?

- $78.12 now
- $1000 twenty-five years from now

Which would you prefer?

- $109.37 now
- $1000 twenty-five years from now

Which would you prefer?

- $140.62 now
- $1000 twenty-five years from now

Which would you prefer?

- $171.87 now
- $1000 twenty-five years from now

Which would you prefer?

- $203.12 now
- $1000 twenty-five years from now

Which would you prefer?

- $234.37 now
- $1000 twenty-five years from now

Which would you prefer?

$265.62 now

- $1000 twenty-five years from now

Which would you prefer?

- $296.87 now
- $1000 twenty-five years from now

Which would you prefer?

- $328.12 now
- $1000 twenty-five years from now

Which would you prefer?

- $359.37 now
- $1000 twenty-five years from now

Which would you prefer?

- $390.62 now
- $1000 twenty-five years from now

Which would you prefer?

- $421.87 now
- $1000 twenty-five years from now

Which would you prefer?

- $453.12 now
- $1000 twenty-five years from now

Which would you prefer?

- $484.37 now
- $1000 twenty-five years from now

Which would you prefer?

- $515.62 now
- $1000 twenty-five years from now

Which would you prefer?

- $546.87 now
- $1000 twenty-five years from now

Which would you prefer?

- $578.12 now
- $1000 twenty-five years from now

Which would you prefer?

- $609.37 now
- $1000 twenty-five years from now

Which would you prefer?

- $640.62 now
- $1000 twenty-five years from now

Which would you prefer?

- $671.87 now
- $1000 twenty-five years from now

Which would you prefer?

- $703.12 now
- $1000 twenty-five years from now

Which would you prefer?

- $734.37 now
- $1000 twenty-five years from now

Which would you prefer?

- $765.62 now
- $1000 twenty-five years from now

Which would you prefer?

- $796.87 now
- $1000 twenty-five years from now

Which would you prefer?

- $828.12 now
- $1000 twenty-five years from now

Which would you prefer?

$859.37 now

- ○ $1000 twenty-five years from now

Which would you prefer?

- ○ $890.62 now
- ○ $1000 twenty-five years from now

Which would you prefer?

- ○ $921.87 now
- ○ $1000 twenty-five years from now

Which would you prefer?

- ○ $953.12 now
- ○ $1000 twenty-five years from now

Which would you prefer?

- ○ $984.37 now
- ○ $1000 twenty-five years from now

Diabetes medication adherence

Now, I am going to ask some questions about your health. Have you been diagnosed with diabetes by your health care provider?

- ○ Yes
- ○ No

Do you currently take medications for your diabetes?

- ◯ Yes
- ◯ No

In the box below, type the **TOTAL NUMBER** of medications you are currently taking on a regular basis. Include any over-the-counter medications, herbal products, and vitamins you are currently taking, as well as prescriptions.

In the box below, type the **TOTAL NUMBER** of prescription medications you take orally for your diabetes on a regular basis. **Do not include injectable medications.**

Which diabetes medications are you currently taking? Check all that apply.

- ☐ Acarbose (Precose)
- ☐ Glimepiride (Amaryl)
- ☐ Glipizide (Glucotrol, Glucotrol XL)
- ☐ Glyburide (DiaBeta, Glynase Pres Tab, Micronase)
- ☐ Metformin (Fortamet, Glucophage, Glucophage XR, Glumetza, Riomet)
- ☐ Miglitol (Glyset)
- ☐ Nateglinide (Starlix)
- ☐ Pioglitazone (Actos)
- ☐ Repaglinide (Prandin)
- ☐ Rosiglitazone (Avandia)
- ☐ Sitagliptin (Januvia)
- ☐ Tolazamide (Tolinase)
- ☐ Actoplus (Metformin and Pioglitazone)
- ☐ Avandamet (Metformin and Rosiglitazone)
- ☐ Avandaryl (Rosiglitazone and Glimepiride)
- ☐ Duetact (Pioglitazone and Glimepiride)
- ☐ Janumet (Metformin and Sitagliptin)
- ☐ Metaglip (Glipizide and Metformin)
- ☐ None of the above

Diabetes Medication

How many times per day do you take ${lm://Field/1}?

- ◯ 1 time
- ◯ 2 times
- ◯ 3 times
- ◯ 4 times or more

You indicated that you are taking ${lm://Field/1} for your diabetes. Individuals have identified several issues regarding their medication-taking behavior and we are interested in your experiences. There is no right or wrong answer. Please answer each question based on your personal experience with your diabetes medication. Do not include injectable medications.

Do you sometimes forget to take ${lm://Field/1}?

- Yes
- No

People sometimes miss taking their medications for reasons other than forgetting. Thinking over the past two weeks, were there any days when you did not take ${lm://Field/1}?

- Yes
- No

Have you ever cut back or stopped taking ${lm://Field/1} without telling your doctor, because you felt worse when you took it?

- Yes
- No

When you travel or leave home, do you sometimes forget to bring along your ${lm://Field/1}?

- Yes
- No

Did you take your ${lm://Field/1} yesterday?

- Yes
- No

When you feel like your diabetes is under control, do you sometimes stop taking ${lm://Field/1}?

- Yes
- No

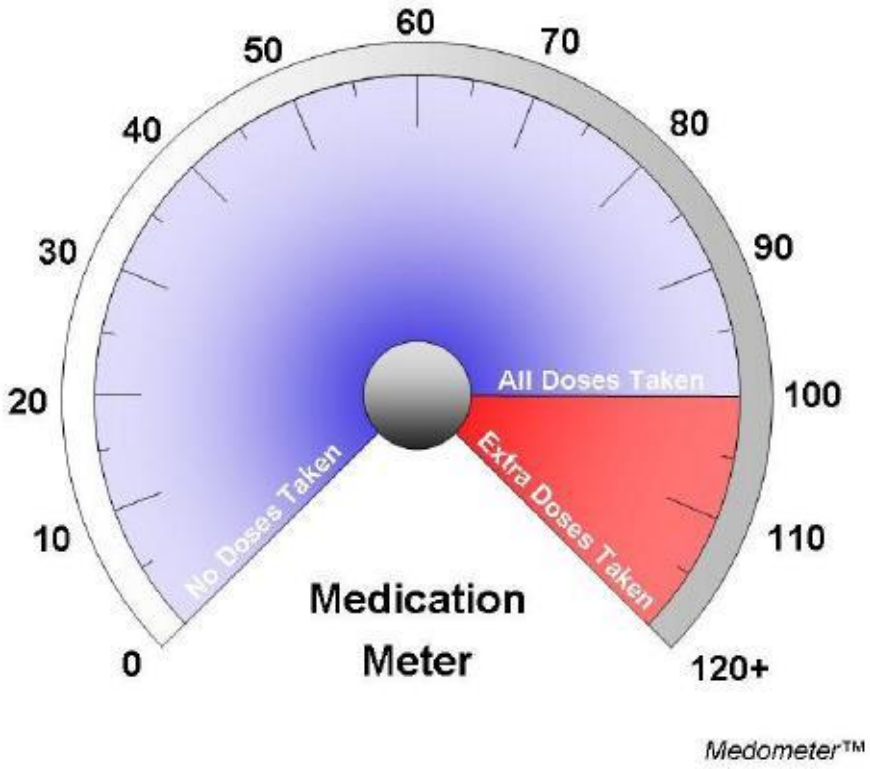
Taking ${lm://Field/1} every day is a real inconvenience for some people. Do you ever feel hassled about sticking to your diabetes treatment plan?

- Yes
- No

How often do you have difficulty remembering to take your ${lm://Field/1}?

- Never/Rarely
- Once in a while
- Sometimes
- Usually
- All the time

Now, think about the ${lm://Field/1} you are currently taking. Look at the picture below and think about how often you take your dose correctly as prescribed by your healthcare provider. Zero represents no doses taken, 100 represents all doses taken, and 100 to 120+ represents extra doses taken.



Now choose any number between 0 and 120 that represents how often you take your dose of ${lm://Field/1}. Enter the number in the box below.

Demographics

What is your sex?

- Male
- Female

Approximately how tall are you without shoes (in feet and inches)?

Feet

Inches

Approximately how much do you weigh without shoes (in pounds)?

What is your current age (in years)?

What is your marital status?

- Single (never married)
- Currently married
- Separated, divorced or widowed

What is the highest level of education you have completed?

- Less than high school
- High school
- Some college
- Bachelor's or Associate's degree
- Graduate or professional degree

What is your total annual household income?

- Less than $20,000 per year
- $20,000 to $59,999 per year
- $60,000 to $99,999 per year
- $100,000 to $129,999 per year
- $130,000 or more per year

Are you of HIspanic, Latino, or Spanish origin?

- Yes
- No

What is your race? Check all that apply.

- [ ] White/Caucasian
- [ ] Black/African American
- [ ] American Indian or Alaskan Native
- [ ] Asian
- [ ] Pacific Islander
- [ ] Other

Please indicate which of the following best describes your position at Auburn University.

- Faculty
- Administrator
- Professional
- Secretarial/Clerical
- Technical
- Skilled Crafts
- Service/Maintenance
- GTA/GRA
- Retired
- I am not an employee of Auburn University
- None of the above
- I prefer not to say

Congratulations! You have now completed the survey. When you click the "Next" button below, you will be redirected to another page where you may enter your contact information. If you provide your contact information, your name will be entered in a drawing for a chance to win one of two $100 cash prizes. If you do not wish to provide your contact information, simply leave those items blank and click the button to complete the survey.

Contact Information

If you provide your contact information below, your name will be entered in a drawing for a chance to win one of two $100 cash prizes. If your name is drawn, you will be contacted and given instructions for how to claim your prize.

What is your first and last name?

First Name

Last Name

What is the best telephone number to reach you during the daytime?

What is the best telephone number to reach you in the evening (after 5 pm)?

Please provide an e-mail address. We will only use this address to notify you in the event that you are a winner.

What is your mailing address?

Street Address

City

State

ZIP code