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Walden University
2018

Abstract

Factors Associated With Adherence to Diabetes Medication

Among Individuals With Type 2 Diabetes

in Cambridge, Ontario, Canada

by

Benedict Atekha

MS, University of Lagos, 2002

BPharm, University of Benin, 1992

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health

Walden University

February 2018

Abstract

Although it is known that the prevalence of type 2 diabetes is on the rise in Canada, more information is needed on how well type 2 diabetes patients living in Cambridge, Ontario self-manage their diabetes and what factors influence their adherence to diabetes medication regimens. The objective of this cross-sectional study based on the theory of planned behavior was to determine if there are predictors of adherence to diabetes medications among patients living with type 2 diabetes in Cambridge. The World Health Organization STEPwise Approach to Surveillance was used to collect demographic data. Adherence and diabetes knowledge were assessed with the 8-item Morisky Medication Adherence Scale and the Michigan Diabetes Knowledge Test, respectively. Research subjects were 56 adults recruited through convenience sampling. Predictor variables that were tested included age, gender, level of education, and diabetes education, and the response variable was adherence to diabetes medication. Level of education (p = .001) was the only strong predictor of adherence to diabetes medication in the bivariate logistic regression analysis. In addition, in the multivariate logistic regression analysis, the following combined variables were significantly associated with adherence to type 2 diabetes medication: age and level of education; age and diabetes knowledge; gender and level of education; gender and diabetes knowledge; and level of education and diabetes knowledge. Application of the findings of this study may help to minimize the risk of diabetes-associated complications and improve quality of life for those with type 2 diabetes, thereby reducing type 2 diabetes healthcare costs for patients, insurance payers, and other stakeholders.

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Dedication

I dedicate this dissertation to God, for without Him, completing this program would have been impossible. Also, I dedicate this work to my father and my mother. Without them, I would not be alive. Both of them encouraged me to further my education. I grew up in Benin City, Nigeria, where daily living was not easy, and in spite of the challenges, my parents made so many sacrifices to make sure I went through pharmacy school; they were always there for me. My father would be very proud of me if he were still alive, but God had a better plan for him, and may God bless his gentle soul. In addition, I dedicate this work to my wonderful children, Osazee, Eseosa, Oghogho, Nosa, and Uyiosa, who have been of tremendous support and encouragement. Lastly, I dedicate this work to my brothers and sisters, Esther, Sunday, Helen, Osarobo, Osaretin, Osaretin, Monday, Imutinyan, and Osariemen. We all grew up together in Benin City, and we always work for the good of one another. They always encourage me, and they do their best in whatever way they can for me to have a better life and further my education.

Acknowledgments

This final volume of my dissertation was made possible through the great mentorship of all of my dedicated committee members, whose encouragement critique, guidance, advice, and patience made this research a reality. I am sincerely grateful to the chair of my committee, Dr. Loretta Cain for her patience and great leadership skills in coordinating this whole dissertation process. Dr. Cain's patience and support including her quick response in reviewing my work made the completion of this dissertation a reality. I am indebted to Dr. Shingairai Feresu, my second committee member, for her thoroughness and diligence in directing my attention to clarity and detail. I am equally thankful to Dr. Gudeta, University Research Reviewer, for directing my focus to important details, and for his constructive feedback, without which this dissertation would be incomplete. I wish to extend my appreciation to Kole Kuye, pharmacy owner of Medicine Shoppe pharmacy for allowing me to use Medicine Shoppe pharmacy as my research center, as well as all of our wonderful patients who agreed to be participants in this study. I am grateful to my wife, Philomena, for all her inputs during this phase of my education. Thanks to my dad of blessed memory for all his sacrifice and encouragement. He always encouraged me to get to the highest limits in education. He is one of my heroes. Also special thanks to my family and friends for all their support and encouragement.

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List of Abbreviations and Acronyms

ADA	American Diabetes Association
AMA	American Medical Association
APHA	American Public Health Association
BMI	Body mass index
BRFSS	Behavioral risk factor surveillance system
CAD	Coronary artery disease
CDA	Canadian Diabetes Association
COPD	Chronic obstructive pulmonary disease
DCCT	Diabetes Control and Complications Trial
DK	Diabetes knowledge
DTSQ	Diabetes Treatment Satisfaction Questionnaire
FBG	Fasting blood glucose
HF	Heart failure
IDF	International Diabetes Federation
IRB	Institutional Review Board
MMAS	Morisky Medication Adherence scale
NIH	National Institutes of Health
PAID	Problem Areas in Diabetes
PHAC	Public Health Agency Canada
SES	Self-Esteem scale

SMBG	Self-monitoring of blood glucose
SN	Subjective norm
TPB	Theory of planned behavior
UKPDS	United Kingdom Prospective Diabetes Study
VIF	Variance inflation factor
WHO	World Health Organization

Chapter 1: Introduction to the Study

Diabetes mellitus is a chronic, debilitating medical condition with potentially distressing complications. It affects people of all ages and races worldwide. About 30 million people worldwide were diagnosed with diabetes in 1985; by 2000, that number had increased to more than 150 million (Cheng, 2013). The International Diabetes Federation (IDF) estimated that in 2014, 387 million people worldwide had diabetes, and it is projected that this number will increase to 592 million by 2035 (International Diabetes Federation, 2014). Africa and other developing nations are expected to have the highest increase in numbers of people diagnosed with diabetes because of poverty and poor healthcare facilities (International Diabetes Federation, 2014). Developed nations such as Canada are also significantly impacted by the menace of diabetes, which is known to be a leading cause of mortality and morbidity (Cheng, 2013).

The prevalence of diabetes has been increasing dramatically in Canada (Public Health Agency of Canada [PHAC], 2011). The city of Cambridge, with a population of about 200,000 people is located in the southwestern part of the Canadian province of Ontario. There is presently no published information about the factors associated with adherence to diabetes management in Cambridge. The approximated prevalence of diabetes mellitus in Canada was 6.8% in 2009 (Public Health Agency of Canada, 2011). This value indicated an alarming 230% increase when compared to the estimate for 1998 (Cheng, 2013). Several factors including overweight, obesity, physical inactivity, unhealthy eating, tobacco smoking, an aging population and sedentary lifestyle are

commonly linked to diabetes prevalence in Canada (Public Health Agency of Canada, 2011). It is generally speculated that the incidence and prevalence of diabetes among Canadians are much higher than in past decades and these figures are projected to continue to increase in the future (Cheng, 2013). In Canada, diabetes is one of the principal causes of cardiovascular diseases, blindness, amputation in adults and end-stage kidney disease. Diabetes and related complications raise total costs and service demands on the healthcare system in Canada. According to Cheng (2013), effective management of diabetes would result lower healthcare costs and reduced incidence of diabetes-associated mortality and morbidity.

Adherence to prescribed diabetes medication is key to the accomplishment of glycemic control and diabetes management goals (Fedrick & Justin-Temu, 2012). *Adherence* refers to the committed, noncompulsory, and cooperation of the patient in the jointly agreed course of action to produce a curative outcome (Delameter, 2006). Results from several studies have suggested that fewer risks of undesirable outcomes are noticed when patients take their medications as prescribed (Granger et al., 2005; Horwitz et.al, 1999; Simpson, Eurich, et al., 2006). Diabetic and cardiac patients who take medication according to their physician's recommendation have a 7% death rate whereas those who refuse to follow medical advice have a 12% death rate (Khan, Al-Abdul Lateef, Al Aithan, Bu-Khamseen, & Khan, 2012). *Nonadherence*, in the context of healthcare, refers to the degree to which a patient's behavior (relating to taking medication, adhering to lifestyle change directives, completing medical tests, or keeping physician appointments)

concurs with a healthcare provider's health and medical advice (Partridge, Avorn, Wang, & Winer, 2002). *Nonadherent patients* are individuals whose health-seeking or maintenance behaviors are not in agreement with a healthcare provider's recommendations (Jin, Sklar, Min Sen Oh, & Chuen Li, 2008). Patient nonadherence is a serious issue in healthcare because it hinders successful healthcare delivery and promotes negative health outcomes. In almost every country in the world, nonadherence has been reported as a serious problem, and in the United States, one-third to one-half of patients are nonadherent (Khan et al., 2012). Adherence to prescribed medications is of great concern to prescribers, governments, and other stakeholders because of the increasing evidence that shows that the refusal of patients to take their medications as prescribed is related to higher cost burdens on the healthcare system and preventable adverse outcomes (Osterberg & Blaschke, 2005). In Canada, many patients, including those with diabetes, show poor adherence to their prescribed medications (Law, Cheng, Dhalla, Heard, & Morgan, 2012). Consequently identifying factors that are linked to adherence to diabetes management plan may assist in the improvement of diabetes management and prevention of diabetes-related complications among diabetes patients in Cambridge.

Chapter 1 is divided into 12 sections. Literature on the effect of diabetes and adherence to diabetes medication regimens is discussed in the introduction and background sections. The issue addressed in this study and the intention of this research are discussed under the problem statement and the purpose of the study, respectively. The research questions and the null and alternative hypotheses are also discussed in this

chapter. The study's theoretical framework is also described, including pertinent information related to the theories that informed this study and the relationship of theory to this study. The study design and the main reasons for choosing it are discussed under the nature of the study. Additionally, I present definitions of terms used in this study, and I explain the dependent and independent variables. The assumptions, scope, limitations, delimitations, and significance of the study are also discussed in this chapter.

Background

Adherence to a diabetes treatment plan is vital to the achievement of the diabetes mellitus management goals. Nonadherence to a management regimen is perhaps the main reason for preventable undesirable health outcomes among diabetes patients. The rate of adherence to the task of taking medication as prescribed varies, yet, have consequences on health outcomes and treatment effectiveness (Fedrick & Justin-Temu, 2012). The incidence and prevalence of diabetes mellitus are on the rise in Canada and in a number of other nations around the world (Public Health Agency of Canada, 2011). The most recent comprehensive Canada-wide diabetes prevalence study was conducted between 2008 and 2009 by the Canadian Chronic Disease Surveillance System (Public Health Agency of Canada, 2011). In this study, the diabetes status of Canadians ≥ 1 year old at the time of the study was assessed. Results of the research show that the prevalence of diabetes in Canada in 2009 was 6.8%. This indicated that about 2.4 million Canadians had diabetes in 2009. It is projected that the numbers of Canadians with diabetes will increase to about 3.7million by 2019 (Public Health Agency of Canada, 2011). All ages

and ethnic groups that make up the Canadian population are affected by diabetes. The groups that have a higher risk of developing diabetes include Aboriginal Canadians and individuals of Hispanic, Asian, and African descent (Canadian Diabetes Association, 2011b). Diabetes is among the commonest chronic diseases in Canada, and if not effectively managed, it can result in eye disease, nerve damage, erectile problems, heart disease, and higher healthcare costs (Canadian Diabetes Association, 2013; Cheng, 2013). For this reason, it is important for researchers to continue to concentrate on investigations that may promote effective management of the disease.

Management of diabetes generally starts immediately after diagnosis (Canadian Diabetes Association, 2013). Effective management of diabetes usually requires a coordinated multidisciplinary approach. In Canada, the team of healthcare professionals involved with diabetes management includes family physicians, endocrinologists, nurses, dietitians, pharmacists, and exercise specialists. All of these health professionals work together with the patient to achieve optimal glycemic control (Canadian Diabetes Association, 2013; Borgermans, Goderis, & Van Den Broeke, 2009). Diabetic patients have to be able to understand, properly follow, and implement clear instructions from each of these healthcare providers in order to reach good glycemic control (Ortiz, Cabriales, Gonzalez, & Meza, 2010). Expected patient self-care behavior in diabetic care plan management usually includes (a) self-monitoring blood glucose (SMBG); (b) using prescribed medications as instructed; (c) exercising regularly; (d) following a meal plan; and (e) keeping doctor's appointments (Chatterjee, 2006; Funnell & Anderson, 2004;

Poskiparta, Kasila, & Kiuru, 2006; Xu, Pan, & Liu, 2010). Executing these roles or behaviors imposes daily demands on the time and comfort of people living with diabetes, and successful implementation of these behaviors is mostly dependent on patient willingness and competence (AlJasem, Epirot, Wissam, & Rubin, 2001). Patients' strict adherence to diabetes self-care plans plays an important role in improving their quality of life; however, complying with diabetic care plans is often difficult for patients and represents a big challenge for healthcare professionals.

One study (Cramer, 2004) involved an extensive systematic review of adherence to prescriptions by diabetes patients. The purpose of the study was to estimate the extent to which diabetes patients omitted their medications. The author reviewed related literature from 1966 to 2003 to identify quantitative data that related to adherence to diabetes medications. The investigator was able to identify needed records of adherence in several retrospective and prospective studies. Analysis of the retrospective studies indicated that adherence to oral hypoglycemia medications was between 36% and 93% in patients who had been receiving treatment for six to 24 months. Analysis of prospective data showed that adherence was from 67% to 85% of prescribed oral diabetes doses. Adherence to insulin prescriptions was noted to vary from 62% to 64% among adults, while young individuals suffering from diabetes only filled about 33% of the doses of insulin prescribed to them. The researcher concluded that patients with diabetes were generally poor adherers to both oral and injectable diabetes medications (Cramer, 2004).

Adherence to diabetes medication continues to be a serious healthcare issue in various cultures and communities in Canada, including those in Cambridge. Increasing the rate of medication adherence among diabetics in Cambridge communities may help to reduce the clinical risk associated with diabetes. Investigators have studied adherence to diabetes management in various communities and have identified several factors that influence adherence to diabetes medication in the communities where the studies were conducted. Failure to keep appointments (Rhee et al., 2005), poor health provider-patient communication (Ciechanowski, Kato, Russo, & Walker, 2001), taking several different pills (Marcum & Gellar, 2012), and low levels of patient education (Peyrot & Rubin, 1994) have been identified as factors in poor adherence to diabetes medications. Additionally, adherence to medication is influenced by religious beliefs and local traditions (Collins-McNeil et al., 2012). Review of the literature shows that factors that impact adherence may vary from one community to another. For instance, the authors of an adherence study conducted in Saudi Arabia claimed that female gender is one of the important factors that influence adherence to diabetes treatment plans (Khan et al., 2012). In another study conducted in one of the largest diabetes clinics in Ethiopia, the authors indicated that gender did not significantly influence diabetes medication adherence (Gelaw et al., 2014). In view of the fact that no diabetic adherence study had been conducted in Cambridge, I conducted this study to address a gap in the literature. This study adds to the existing body of research that relates to adherence to debates medication

management regimens by identifying factors that are linked to adherence to diabetes management in Cambridge.

Problem Statement

The management of chronic diseases, including diabetes, generally involves the use of medications for a long period of time. Even though studies have shown the beneficial effects of using pharmacotherapy in chronic disease management, its usefulness has not been fully appreciated, given that close to 50% of patients with chronic diseases do not take their prescriptions as recommended by their healthcare practitioners (Brown & Bussell, 2011).

Despite the fact that medical services are freely available to all Canadians, diabetes mellitus remains a very serious medical and public health issue in Canada (Canadian Diabetes Association, 2013; Public Health Agency of Canada, 2011). Although diabetes is becoming increasingly prevalent in Cambridge, as in Canada as a whole, no investigations have been conducted on preventive methods that involve diabetes knowledge, awareness of diabetes risks, and lifestyle factors that could help to improve adherence to diabetes medications in Cambridge. My review of the literature indicated that no adherence studies among individuals with diabetes in Cambridge had ever been conducted. Studies evaluating the impact of the combination of predictors of adherence are also not available. Moreover, barriers leading to nonadherence to diabetic self-management and self-care behaviors were yet to be determined in Cambridge. Investigators have noted that educational level, female gender, inconsistency in follow-

up, noncompliance with prescription medications, noncompliance with prescribed exercise regimen, use of injectable insulin with oral metformin, and injectable insulin and living in an urban area are important factors linked to adherence to diabetes management plans (Khan et al., 2012). Lack of proper understanding of diabetes medication regimen, inability to afford some or all prescribed medications, and time lags between visits to health workers have also been shown to be associated with adherence to medication regimens (Kalyango, Owino, & Nambuya, 2008). However, no research has been conducted to determine whether gender, age, socioeconomic status, diabetes knowledge, dosing frequency, duration of disease, self-efficacy, and alcohol use are associated with adherence to diabetes management in Cambridge. Identifying and comprehending factors relating to adherence are important in changing the lifestyle and other characteristics in order to support treatment adherence and good health. Consequently, it is important to examine factors related to adherence to diabetes medications in Cambridge because such knowledge can add to the literature related to diabetes management in Canada and beyond.

Purpose of Research

The purpose of this cross-sectional quantitative research was to identify and evaluate links between age, gender, level of education and diabetes knowledge and adherence to diabetes medication among individuals with type 2 diabetes in Cambridge. A proper understanding of the effect of independent variables, such as age, gender, level of education, diabetes knowledge on adherence to diabetes medication (dependent

variable) could assist in the development of more effective nonadherence preventive strategies that could reduce the incidence of diabetes complications, reduce diabetes management costs, and promote improved quality of life for individuals with diabetes in Cambridge.

Theoretical Framework

The theory of planned behavior (TPB) developed by Ajzen (1991, 2005) was used in this study to provide the framework for a proper understanding of factors and dynamics involved in the association between patients' perceptions, attitudes, and beliefs in relation to performing certain behaviors that promote adherence to prescribed diabetic treatments (Ajzen, 2001). As Ajzen (2001) explained, "The theory of planned behavior indicates that people act in accordance with their intentions and perceptions of control over the behavior, while intentions in turn are influenced by attitudes toward the behavior, subjective norms, and perceptions of behavioral control" (p. 43). Adhering to prescribed medications or management plans involves planned or intended behaviors. For instance, when an individual is prescribed one or more medications, some definite or specific behaviors are vital for the medication to be beneficial, such as taking the prescribed medication as directed(e.g., once daily in the morning, or every 8 or 12 hours with or without food). However, it is the duty of the patient to execute the required expected behavior and ensure adherence to medications. Individuals that have the ultimate goal of controlling their blood sugar or diabetes will routinely adhere to

prescribers' directives of taking their medications and will follow other management plans strictly.

TPB is an offshoot of the theory of reasoned action (TRA; Ajzen & Fishbein, 1980). TPB is a complete behavioral theory because it provides a basis for predicting behavior and adjustments (Casper, 2007). It is assumed in the formulation of TPB that people are sensible beings who are capable of making logical judgments. TPB is not applicable to motives that are unconscious. TRA holds that the intention to exhibit a particular behavior or perform an action can be predicted by subjective norms and attitudes. TRA is associated with voluntary behavior; it is related to causal experience of intentions to execute behaviors over which individuals have sufficient control (Ajzen, 2005, p. 117). It was assumed in the development of TRA that individuals have volitional control over all of the behavior that they want to perform—that is, individuals are able to perform specific behaviors if they want to. However, problems crop up with TRA whenever the theory is applied to behaviors that are not completely under volitional control (Ajzen, 1991).

In 1985, Ajzen included a third construct or component of perceived behavior to TRA, at which point he renamed the theory as the *theory of planned behavior* (Ajzen, 1991, 2005). This third component was added because Ajzen (1991) noted that the majority of behaviors humans engage in are not under volitional control. *Perceived behavioral control* refers to a person's perceptions of his or her ability to execute behavior of interest. The inclusion of the component of perceived behavioral control

made it possible for TPB to explain the likelihood of partial control of volition (Ajzen, 1991, 2005). The three components that make up TPB—attitude, perceived behavior, and subjective norms—are categorized as higher level theoretical constructs by scientists and this theory is designed to help predict and give explanations to human behavior under certain circumstances. Behavior is a "function of salient information, or beliefs, relevant to the behavior" (Ajzen, 1991, p. 189). Behavior can be planned or deliberate. TPB, as depicted in Figure 1, is the most appropriate theoretical framework for this research because it can predict deliberate or planned behavior.

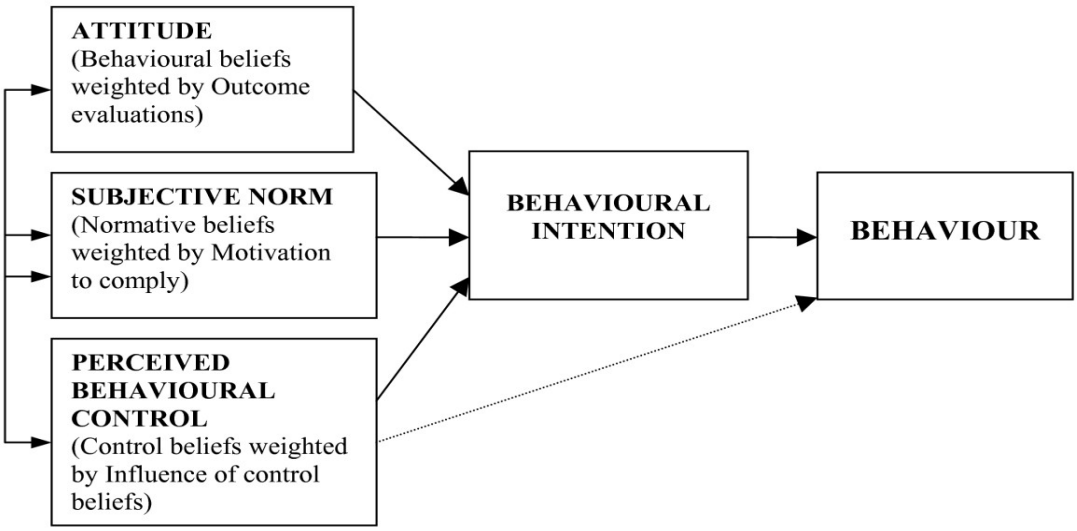

Figure 1. Model of the theory of planned behavior. From Ajzen (1991), "The Theory of Planned Behavior, " *Organizational Behavior and Human Decision Processes, 50*, p. 182. Copyright 1991 by I. Ajzen. Adapted from public domain with author permission

Nature of Study

Cross-sectional design is the research design method that is predominately used by researchers to investigate various socioeconomic and cognitive areas of adherence to

medication regimens. In social science research, this design method is one of the most commonly used (Frankfort-Nachmias & Nachmias, 2008). Like several previous adherence research studies, this quantitative research study used a cross-sectional design to determine the factors that are related to adherence to diabetes medication regimens among individuals with type 2 diabetes in Cambridge.

Three data-gathering instruments were used in this study. Patients' demographic data were collected with the aid of the World Health Organization STEPwise Approach to Surveillance (WHO STEPS) demographic instrument, diabetes knowledge was assessed with the aid of the Michigan Diabetes Knowledge scale, and medication adherence was measured with Morisky Medication Adherence scale. This study concentrated on diabetic patients aged 18 years and over who received their prescription and nonprescription medications from Metro Pharmacy Limited in Cambridge. Data analysis was conducted with the aid of logistic regression analysis, which assisted in determining the strength of relationships and the significance of each independent variable in terms of adherence to diabetes medication (dependent variable).The objective of this investigation was to evaluate predictors of adherence to diabetes medications. As a result, I sought to explore the impact of the independent variables—age, gender, level of education, and diabetes knowledge—on adherence to diabetes treatment, which was the dependent variable. The study methodology used for this research is discussed fully in Chapter 3.

Research Questions and Hypotheses

The questions below were used to explore the influence of age, gender, level of education, and diabetes knowledge on adherence to diabetes management in Cambridge, Ontario, Canada. The major research questions involved four independent variables and only one dependent variable. Hypotheses based on these questions were tested.

RQ1: Are the variables age, gender, diabetes knowledge, and level of education associated with adherence to diabetes medication among individuals with type 2 diabetes in Cambridge?

Ho1: There is no relationship between age and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

*H*a1: There is a relationship between age and adherence diabetes medications among individuals with type 2 diabetes in Cambridge.

Ho2: There is no relationship between gender and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

*H*a2: There is a relationship between gender and adherence to medications among individuals with type 2 diabetes in Cambridge.

H03: There is no relationship between diabetes knowledge and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

*H*a3: There is a relationship between diabetes knowledge and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

H04: There is no relationship between level of education and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

*H*a4: There is a relationship between level of education and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

RQ2**:** Are any pair-wise combinations of the variables age, gender level of education and diabetes knowledge linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge?

*H*o5: The age and gender combination is not significantly linked to adherence to diabetes medications among people with type 2 diabetes in Cambridge.

*H*a5: The age and gender combination is significantly linked to adherence to type 2 diabetes medication among individuals with diabetes in Cambridge.

*H*o6: The age and level of education combination is not a significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*a6: The age and level of education combination is significantly linked to adherence diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*o7: The age and diabetes knowledge combination is not significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*a7: The age and diabetes knowledge combination is significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*o8: The gender and level of education combination is not significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*a8: The gender and level of education combination is significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*o9: The gender and diabetes knowledge combination is not significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*a9: The gender and diabetes knowledge combination is not significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*o10: The level of education and diabetes knowledge combination is not significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*a10: The level of education and diabetes knowledge combination is significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

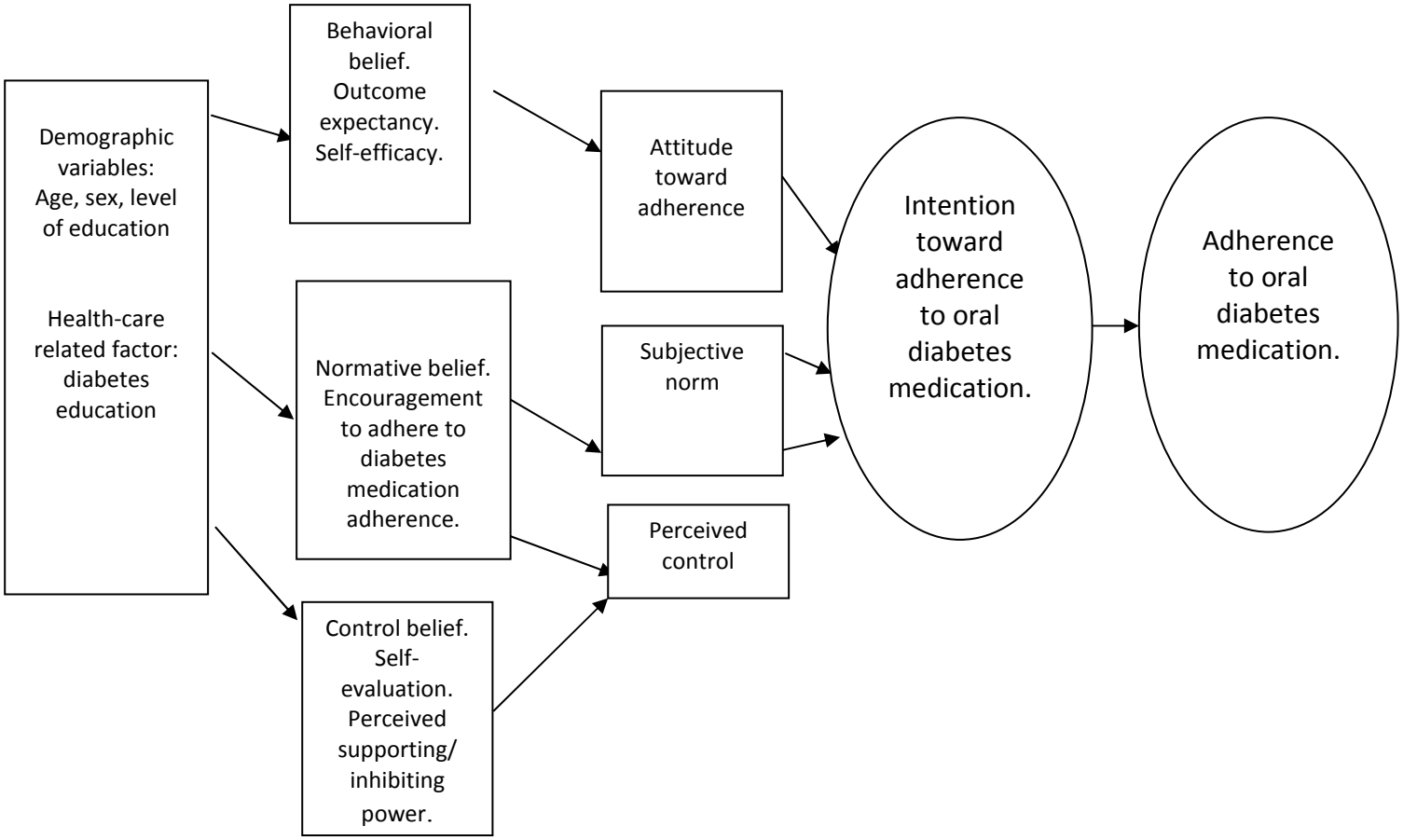

Figure 2. Theoretical model for this study. Fully diluted model adapted and modified from I. Ajzen (1991) "The Theory of Planned Behavior, " *Organizational Behavior and Human Decision Processes, 50*, p. 182. Copyright 1991 by I. Ajzen. Adapted from public domain with author permission

Assumptions

I made the assumption that study participants were volunteers who participated willingly and not under any inducement so as not to bias the study. Further, I assumed that diabetic patients who participated in this study provided complete and correct answers to the survey questions. Last, I assumed that all data-gathering instruments used in the study correctly measured the variables that were tested.

Limitations

This study was a cross-sectional study that concentrated on the link between the factors influencing diabetes medication adherence (independent variables) and adherence to a diabetic medication regimen (dependent variable). Because the study was cross-sectional and involved measurement of association, causation was not explored. I hypothesized that age, gender, level of education, and diabetes knowledge would impact adherence to medications, and as a result I used bivariate logistic analysis to identify the direction of the association between the dependent variable and the independent variables. A cross-sectional research design was best for this study because the aim of the study was to identify factors that impact diabetes adherence status in Cambridge. The results from this investigation were limited to diabetes patients living in Cambridge and should not be generalized to diabetic populations that are dissimilar to that in Cambridge.

Scope and Delimitations

This investigation was a quantitative study and did not explore the reasons why participants in the study behaved in the ways they did. This study concentrated on

adherence to diabetes medication regimens among patients living in Cambridge, and the scope of the study did not include other medical conditions such as cardiovascular diseases, which are likely linked to dissimilar problems of adherence. Criteria for inclusion included diagnosis with diabetes, 18 years of age or older, and residing in Cambridge. Criteria for exclusion included prediabetic status, using only a lifestyle modification method to control diabetes, and inability to read, write, or understand the English language.

Significance

Diabetes mellitus has developed into a global epidemic. When not managed properly, diabetes can result in complications that may lead to higher healthcare costs and poor quality of life (Blackburn, Swidrovich, & Lemstra, 2013). Proper management of the disease would lead to better health outcomes and lower healthcare costs. Moreover, a good understanding of the roles of age, gender, level of education and diabetes knowledge on adherence to diabetes medication can help in the development and use of more effective interventions. In that there is presently no research in the literature on adherence to diabetes medications among diabetic patients in Cambridge, identifying the variables that influence diabetes adherence status for this population is beneficial. Data and results from this study contribute to increase the level of useful knowledge possessed by diabetes educators, health intervention developers, nurses, family physicians, internal medicine specialists, endocrinologists, and other clinicians involved in diabetes management who are looking for ways to improve adherence to diabetes management

among diabetic patients in Cambridge. Another potential benefit of this research is the promotion of social change through the provision of valuable information that helps health practitioners to better assist and educate patients on how they can be positively and actively involved in their healthcare, especially in the area of adherence to prescribed medications.

Definitions of Terms

Diabetes mellitus: A chronic illness characterized by inability of the body to control blood sugar levels within normal range (CDA, 2013).

Diabetic patient: A person diagnosed with diabetes and having A1C values greater than 7whoreceives treatment from a heath care provider (CDA, 2013).

Adherence: The degree to which individual patients comply with the directives that are provided by healthcare practitioners for the management of their medical condition (Bissonnette, 2008).

Chronic diseases: Noncommunicable illnesses that are continual or persistent in nature and are hardly ever treated completely. A person can be affected by a chronic illness for a few months or longer. Sometimes, a chronic illness can be due to an inherited gene (Canadian Diabetes Association, 2009).

Socioeconomic status: This status is based on income earned yearly.

Attitude toward the behavior: Describes an individuals' disposition to an action and the consequence of the action that determines whether behavior change is necessary (Ajzen, 2001).

Perceived behavioral control: Individuals ‘ perception about whether or not they possess the ability to carry out or execute a particular behavior (Ajzen, 2001).

Subjective norm (SN): Perceived pressure from close associates to perform or not perform a specific behavior (Ajzen, 2001).

Self-efficacy: Person’s ability to effect control over issues affecting his or her life (Bandura, 1989). In this study, self-efficacy involved prevention of diabetes and associated complications.

Diabetes knowledge: Knowledge acquired during a diabetes education program that assists individuals in properly understanding diabetes and how to adequately manage the condition (Khunti, Camosso-Stefanovic, Carey, Davies, & Stone, 2008).

Behavior: According to TPB, behavior is a determinate of a persons’ compatible intentions and perceptions of the ability to control or execute a particular action (Ajzen, 2005; Ajzen &Fishbein, 1980).

Clinician: A person with the knowledge and authority to diagnose and treat illnesses (U.S. Department of Health and Human Services [USDHHS], 2012a).

Glycemia: The occurrence of glucose in the blood (American Diabetes Association [ADA], 2011).

Glycemic control: HbA1C equal to or less than 7.0% (ADA, 2011; Bartels, 2004).

Healthcare practitioner: A person who assists with supporting patients’ healthcare needs (U.S. Department of Health & Human Services, 2012a).

Hemoglobin A1C or *A1C test*: A test done in a laboratory to measure mean glucose control for the last 2 to 3 months (American Association of Clinical Endocrinologists [AACE], 2009).

Summary

Diabetes and other chronic diseases can be better controlled and managed if patients adhere strictly to treatment plans. Investigators have identified that adherence to medical therapies by those with chronic diseases including diabetes is generally poor. Suboptimal adherence to diabetes treatment contributes to poor glycemic control and continues to be the principal impediment to the achievement of diabetes treatment goals. As a result, it is important for investigators, policy makers, healthcare providers, and other stakeholders to come up with interventions that could bring needed change to address this problem. For this research, I evaluated the factors and barriers that influence adherence to diabetes medication among individuals living with diabetes in Cambridge. In this chapter, literature on diabetes has been briefly highlighted in relation to diabetes prevalence, consequences of nonadherence to diabetes medication, benefits of adherence, diabetes management methods, and appropriate strategies that can assist in identifying factors that influence adherence to diabetes treatment. Although there are several treatment options for diabetes management and control in Cambridge, Ontario, a gap in knowledge indicates a lack of information about the factors that promote adherence or nonadherence to available diabetes treatment options. This study fills a gap in the literature by evaluating factors that influence adherence to diabetic medications among

diabetes patients in Cambridge, Ontario. This research adds to the existing body of research by evaluating the role of sociodemographic characteristic and medication side effects on adherence to diabetes medication in Cambridge.

In Chapter 2, I review important literature pertaining to this study. Chapter 3 contains in-depth descriptions of the research design, study method, study participant selection procedures, and measures for ethical protection of interested individuals. In Chapter 4, I present and discuss the results of the study, and I explain how I arrived at my findings. Chapter 5 includes interpretation of the study results, conclusions, and recommendations for further investigation.

Chapter 2: Literature Review

There is growing concern about the increasing prevalence of diabetes throughout Canada, including in Ontario, where Cambridge, the site of this study, is located (Canadian Diabetes Association, 2009; Cheng, 2013; Public Health Agency of Canada, 2011). Ontario is known to have a much higher numbers of individuals diagnosed with diabetes when compared with most other provinces in Canada (Public Health Agency of Canada, 2011). PHAC (2011) reported that among the Canadian provinces, Ontario has the third-highest number of individuals diagnosed with diabetes. Diabetes self-management behaviors such as proper nutrition, adequate physical activity, medication adherence, blood sugar monitoring, and proper foot care are vital to good quality of life and prevention of diabetes-related complications (Chatterjee, 2006; Poskiparta et al., 2006; Xu et al., 2010). Nonetheless, individuals with diabetes generally fail to adhere to diabetes self-management practices (Blackburn et al., 2013; Nelson, Chapko, Reiber & Boyko, 2005; Xu et al., 2010). Investigators have shown that diabetes patients are less likely than nondiabetic patients to adhere to diabetes medications (Hertz, Unger, & Lustik, 2005), unlikely to adhere to dietary guidelines (Chowdhury, Helman, & Greenhalgh, 2000; Nelson, Reiber, & Boyko, 2002), less likely to engage in physical activity at prescribed levels (Nelson, Reiber, et al., 2002), and unlikely to engage in self-monitoring of blood sugar as recommended (Karter, Ferrara, Darbinian, Ackerson, & Selby, 2000). Additionally, they tend to disregard recommendations regarding foot care (Safford, Russell, Suh, Roman, & Pogach, 2005). Given that no adherence studies

involving diabetes have been conducted in Cambridge, it is important to explore the factors that influence diabetes management behaviors among individuals with diabetes in Cambridge. Insight can be gained from the identification of factors related to diabetes medication adherence in Cambridge.

In this chapter, current literature relevant to my research area is comprehensively reviewed. Topics addressed in this literature include studies of diabetes mellitus, diabetes management regimens including oral and injectable diabetes medications, adherence to diabetes therapies, factors that influence diabetes adherence status, and TPB. Several researchers have reported that investigators have concentrated more on physical activity adherence than on adherence to oral antihyperglycemic medications in individuals with diabetes (Blanchard et al., 2008; Calitri, Lowe, Eves, & Bennett, 2009; Plotnikoff, Lippke, Courneya, Birkett, & Sigal, 2010). This research adds to existing knowledge by concentrating on adherence to oral diabetes medication regimens. Additionally, this study included an in-depth review of intentions, attitude, perceived control, subjective norms and the association of these components to oral diabetes medication regimens. Peer-reviewed journals constituted the majority of journals consulted for this study.

Organization of the Review

This literature review section is arranged into themes (indicated by subtitles) in order to present comprehensive discussion and exploration of important issues that influence diabetes management plans and adherence to diabetes treatment regimens. The literature review begins with a comprehensive review of books, articles and other sources

of information relevant to my study methodology, followed by a review of information related to the research tools. Next, I present literature that relates to diabetes, adherence statues, and factors that influence adherence. Various methods of diabetes management are discussed. In addition, I present information related to TPB, which served as the foundation for this study.

Literature Search Methodology

The bulk of the material I consulted for the literature review consisted of peer-reviewed articles. The majority of the journals included were primary studies. However, secondary information sources such as meta-analyses, governmental research, and books were included to make my research more robust and comprehensive. I used the Walden University Library to search for and obtain useful articles from the MEDLINE, PsycARTICLES, PsycINFO, and CINAHL databases. Other databases that I used included PubMed, SAGE Full-Text collection, Cochrane Library, Health and Medical Complete, and OVID. Articles were also retrieved from Google Scholar and useful websites such as those of World Health Organization, American Diabetes Association (ADA), Centers for Disease Control and Prevention (CDC) , American Medical Association (AMA), and American Public Health Association(APHA). The websites of the Public Health Agency Canada (PHAC) and the Canadian Diabetes Association (CDA) provided statistical information.

Keywords that were employed to search for relevant literature included *diabetes*, *type 1 diabetes*, *type 2 diabetes*, *diabetes prevalence*, *hypoglycemia*, *hyperglycemia*,

adherence, *nonadherence*, *compliance*, *diabetes medications*, *hypoglycemic medications*, *diabetes related complications*, *attitude*, *intensive diabetes management*, and *theory of planned behavior*. Most of the literature used for this study was published between 2004 and 2014. However, useful older articles were also included. Keyword searches yielded 40 full-text articles from PsycINFO, 50 full-text articles from CINAHL, and 310 full-text articles from MEDLINE. In addition, I obtained 1,320 references from Google Scholar. This literature review created the foundation for establishing the significance of this research and served as a gauge or standard to compare the findings of this investigation with those of earlier studies that have explored adherence to diabetic medication regimens.

Theoretical Framework

I used the theory of planned behavior (TPB) as my theoretical framework for this research. This theory provides a basis for exploring behavioral modification, behavior prediction, and psychological processes (Ajzen, 1991; Casper, 2007).

Description of the Theory

TPB, like other psychological theories and models, is based on assumptions. The main assumptions of TPB are that attitudes, perceived behavioral control and subjective norms (SNs) are the main determinants of intentions (Ajzen, 1991, 2005). Additionally, TPB presumes that the degree of intention under consideration partly determines the relative significance of attitude about an expected behavior, as well as perceived behavioral control and subjective norm (Ajzen, 2005). In addition, TPB presumes that

perceived behavioral control has stimulus effects for intentions (Ajzen, 2005, p. 119). The aim of this research is to encourage diabetic patients to adhere to their diabetic medication regimens and other management plans.

The principles of aggregation and cognitive self-regulation form a significant portion of TPB (Ajzen, 1991). The important proposition that underscores the principle of aggregation is the fact that certain behaviors are influenced not only by general disposition, but also by several related factors that are associated with certain or expected behaviors (Ajzen, 1991, p. 180). However, the principle of aggregation does not predict exact behavior under a specific circumstance. Behavioral intentions refer to multiple factors that are associated with certain behaviors (Ajzen, 1991, 2005). As a result, the central principle of TPB is the intention to execute a particular behavior or action. *Intentions* refer to the power that an individual can exercise in order to achieve certain behavioral objectives. In addition, intentions can be described as the value of probability that a person will carry out a particular behavior (Ajzen & Fishbein, 1980, p. 42). Intentions encompass those important factors that control behaviors, which include knowledge, income, gender, ethnicity, race, education, experience, religion, media exposure and religion. These factors are known to also impact adherence to diabetic medication regimens and management plans (Ajzen, 2005). The more powerful an associated intention is, the better probability there is that an individual will perform an intended behavior (Ajzen, 1991). Nonetheless, the intended behavior must originate from a voluntary decision of the individual (Ajzen, 1991, p. 181; Ajzen, 2005, p. 99); the

implication of this is that the individual may decide to perform or not perform the behavior.

Furthermore, it is worthy of note that intentions are subject to time. The shorter the time taken to measure a particular behavioral intention, the greater the probability of getting accurate results and vice versa (Ajzen, 1991, 2005; Ajzen & Fishbein, 1980). Investigators have been able to accurately measure over a short period of time behaviors that causes minor problems from attitude and intentions (Ajzen, 1991).). Over time, people's intentions and attitudes can change; thus, measurement of intentions and attitudes over a long period of time may not accurately predict behavior (Ajzen, 1991). Adhering to diabetic medication is a behavior that creates no harm to the patient; as a result, perceived control, intention and attitude can accurately predict adherence to diabetic management regimen among diabetic patients in Cambridge.

Constructs of the Theory of Planned Behavior

The combination of attitude in respect to a certain behavior, perception of behavioral control, and subjective norms result in the production of behavioral intention (Ajzen, 1991). The TPB consist of four constructs (see Figure 1). According to Ajzen(1991, 2005), intentions are assumed to be a function of attitude concerning a behavior (an individual's overall assessment of ability to execute a behavior), subjective norms (reflection or belief about the expectations of other important people), and perceived behavioral control (belief regarding the presence of factors that may help or hinder the effecting of the behavior). The constructs of intentions, subjective norms,

attitude, and perceived behavioral control form the bedrock of TPB. The more enthusiastic an individual's attitude and subjective norms, and the greater the perceived control, the stronger the individual's intention will be to carry out the expected behavior. Intention is an important construct of TPB. This theory involves an assumption that attitudes toward an expected behavior play a more decisive role for some intentions than for others, for which subjective norms are more important in helping to predict the intended behavior (Ajzen, 2005). In some behaviors, one or two of the constructs may be behavioral intention determinants, whereas in others, all of the constructs—subjective norms, attitude, and perceived behavioral control—are important in determining behavioral intention (Ajzen, 2005). TPB does not involve the extent of control that a person exerts to perform a particular behavior, but it deals with the influence of perceived behavioral control on the performance of the behavior (Ajzen, 2005). TPB involves an assumption that attitude controls behavior mainly through intentions (Ajzen, 2005). Nevertheless, numerous studies have shown that attitude at times directly controls behavior (Bentler & Speckart, 1979; Zuckerman & Reis, 1978).

Empirical Studies That Support the Theory of Planned Behavior

TPB is a valuable theory for predicting health-protective behavior. In a study testing the predictive value of TPB, McCaul, Sandgren, O'Neill, and Hinsz (1993) recruited 219 subjects for a project that was expected to promote adherence to health-protective behaviors (dental hygiene and detection of cancer).The results of the study showed that intention to engage in action that will lead to cancer detection and teeth

flossing is predicted by subjective norms and attitudes. It was also noted that perceived control more significantly added to the prediction of intention to perform the health-protective behaviors when compared to self-efficacy. The results from this study support other studies that show that TPB can predict health-protective behavior (McCaul et al., 1993).

Several other studies have shown strong evidence that intentions to carry out certain behavior can be predicted by attitude, perceived behavioral control and SNs (Ajzen, 1991, 2005). A review of the literature shows that from 1986 to 1991, 16 studies were conducted to determine whether it is possible to predict an individual's intention from attitude, perceived behavior control, and subjective norms (Ajzen, 1991). In all 16 studies, investigators identified a strong correlation that was in the range of 0.43 to 0.94 (Ajzen, 1991), and 0.71 was found to be the mean multiple regression for all of the studies (Ajzen, 1991), thus showing that TPB has high validity and reliability in behavioral intention predictions.

Kopelowicz et al. (2007) studied adherence to medication regimen individuals with schizophrenia using TPB. The results showed test-retest coefficients of .88 for attitude, .91 for subjective norms, and .86 for perceived behavioral control. Consequently, TPB can be regarded as a valid and reliable model for measuring and identifying factors promoting adherence to medication regimen among diabetic patients residing in Cambridge, Ontario, Canada. TPB has been used in several studies to predict diabetes patients' adherence to physical activity recommendations, and in many of these

studies, investigators have observed a strong association of intention and attitude (Blanchard et al., 2008; Calitri et al., 2009; Keats, Culos-Reed, Courneya, & McBride, 2007; Plotnikoff et al., 2010). However, review of the literature indicates that fewer studies have been conducted in the area of adherence to oral and injectable diabetic medications. As a result, this study adds to current research by determining the factors that promote adherence to diabetic management in Cambridge.

A study conducted by O'Neill et al. (2008) employed the TPB theoretical framework to predict adherence to mammogram appointments. The results of the study showed that the TPB model was able to accurately predict the intention of patients in honoring their appointments within the next nine months (O'Neill et al., 2008). Correspondingly, this study adds to current research by determining the factors that promote adherence to diabetic management in Cambridge

The Meaning of Diabetes Mellitus

Diabetes is a common chronic disease that results either when the beta cells of the pancreas do not produce sufficient insulin or when the insulin produced by the pancreas is not effectively use by the body (Goldenberg & Punthakee, 2013). Insulin is the hormone that helps the body control blood sugar. Inside the body cells, sugar is metabolized to produce the energy that people require to live. If sugar is unable to get into the cells due to inadequate insulin or inability to effectively utilize available insulin, sugar increases to detrimental levels in the blood (Goldenberg & Punthakee, 2013). After some time, high levels of blood sugar may fatally compromise virtually all of the organs

in the body, potentially resulting in strokes, heart attacks, kidney failure nerve damage, impotence, blindness, and infections that result in amputations (Goldenberg & Punthakee, 2013; Levitan, Song, Ford, & Liu, 2004).

There are three main types of diabetes: type 1, type 2, and gestational (American Diabetes Association, 2012; Goldenberg & Punthakee, 2013). Individuals with type 1 diabetes mellitus normally are unable to produce their own insulin and as a result need insulin injections to stay alive. Individuals with type 2 diabetes typically are able to produce insulin but cannot do so adequately or are unable to effectively utilize available insulin (American Diabetes Association, 2012; Goldenberg & Punthakee, 2013). Individuals with type 2 diabetes are generally overweight (World Health Organization, 2015). The prevalence of type 1 diabetes complications is much higher compared to type 2 complications (Dall, Mann, et al., 2009). Type 2 diabetes can be prevented or delayed by maintaining a normal body weight, eating a healthy diet, observing regular physical activities and keeping away from smoking (World Health Organization, 2011). Although type 2 diabetes is preventable, it has a substantial economic burden on the healthcare system, given that about 90% of individuals with diabetes have type 2 diabetes (Dall, Zhang, et al., 2010). Gestational diabetes is the glucose intolerance that is diagnosed during pregnancy (American Diabetes Association, 2012; Goldenberg & Punthakee, 2013).

In 2012, an estimated 1.5 million deaths worldwide were directly linked to diabetes (World Health Organization, 2014). Worldwide diabetes prevalence (defined as

a fasting plasma glucose value ≥7.0 mmol/L [126 mg/dl] or taking diabetes medication for elevated blood glucose) in 2014 was about 9% among individuals that were aged 18 years and over (World Health Organization, 2014). It is projected that, by 2030, diabetes may become the seventh leading cause of death worldwide (Mathers & Loncar, 2006).The lowest diabetes prevalence is noted in low-income nations, whereas the highest diabetes prevalence is noted in upper- to middle-income nations (World Health Organization, 2014).

Diabetes is among the most common chronic medical conditions that affect Canadians. The CDA (2011) estimated that about 2.7 million Canadian had diabetes in 2010; this translates to a prevalence of 7.6%. The actual number may be higher, given that many people living with diabetes are undiagnosed for several years (Public Health Agency of Canada, 2011). The high level of diabetes prevalence in Canada is a concern, and the CDA (2011) has projected that by 2020, 10% of the Canadian population will be diabetic.

Significance of Glycemic Control

Achieving or maintaining optimal glycemic target is very crucial in diabetes management (Imran, Rabasa-Lhort, & Ross, 2013). Many individuals living with diabetes find it hard to achieve glycemic control or recommended glycemic levels because their glucose levels are not regularly or correctly monitored by them and their healthcare providers. The most important challenge of diabetes management is how best to accomplish glycemic control (Berard, Blumer, Houlden, Miller, & Woo, 2013). The two

important methods of assessing glycemic control include glycosylated hemoglobin (AIC) testing and patient self monitoring of blood glucose (Berard et al., 2013; Canadian Diabetes Association, 2013). Maintaining and achieving a healthy glycemic target (A1C ≤7%) helps to reduce the risk of microvascular and macrovascular complications (Imran et al., 2013).

Glycosylated Hemoglobin Testing (A1C)

The glycosylated hemoglobin test result indicates what an individual's mean blood glucose level had been in the last three to four months prior to the test (Canadian Diabetes Association, 2013; Imran et al., 2013; McCarter, Hempe, & Chalew, 2006). This is a helpful way of determining how well an individual's blood sugar levels have been controlled over the last three to four months. The A1C test can be conducted at any time during the day, and results are not affected by exercise, diet, and stress. An A1C test result is a reliable indicator of diabetes complication and effectiveness of treatment (Berard et al., 2013). A1C is also a reliable test for diabetes diagnosis and a useful tool for continuous monitoring of blood sugar in diabetes care (Canadian Diabetes Association, 2013). CDA guidelines for the prevention and management of diabetes in Canada recommend that for people with diabetes, an A1C test should be conducted every three months when glycemic control or target is not achieved and when medication is being adjusted. And also that this test should be conducted once every six months when lifestyle and treatment are stable, and target has been consistent (Berard et al., 2013; Canadian Diabetes Association, 2013). It is imperative to ensure that blood sugar level is

under tight control, this means ensuring that blood glycemia is as close as possible to normal (nondiabetic). For an individual to have tight control, fasting blood glucose levels should between 4 to 7mmol/l and a postprandial plasma glucose levels of 5 to 10 mmol/l two hours after meals while A1C should be equal or less than 7% (Imran et al., 2013). Tight blood glucose control is crucial for the prevention of diabetes-related microvascular complications. There is persuasive proof from several randomized controlled trials that improved blood glucose control decreases the risk of diabetes-related microvascular complications but however have no major consequence on macrovascular outcomes in individuals recently diagnosed with type 1 and type 2 diabetes as well as in patients that have been living with type 2 diabetes for a long period of time (Imran et al., 2013). Results from United Kingdom Prospective Diabetes Study (UKPDS) on type 2 diabetes (Stratton et al., 2000) and the Diabetes Control and Complications Trial (DCCT) on type 1 diabetes (The Diabetes Control and Complications Trial Research Group, 1995) indicate a continuous association between A1C and diabetes-related complications. In the UKPDS trial, a 1.0% reduction in A1C was related to up to 37% reduction in the risk of diabetes-associated microvascular complications, about 14% decline in myocardial infarction and about 21% lower rate of deaths from diabetes (Stratton et al., 2000). Meanwhile a decrease of 10% in A1C in the DCCT study was related to between 40 to 50% decline in the risk of progression of retinopathy (The Diabetes Control and Complications Trial Research Group, 1995). Researchers are of the opinion that most of the diabetes-related complication could be avoided by assisting patient to move from very

poorly controlled diabetes to fairly or well controlled diabetes and also that reduction of A1C to 6% from 7% will also further reduce the risk of microvascular complications (Canadian Diabetes Association, 2013). In addition A1C reduction has been associated with reduction in the cost of managing diabetes (Gilmer et al., 2005). One study uses data from a Minnesota health plan to investigate the impact of AIC, Cardiovascular disease and depression on healthcare cost among those living with diabetes. The analysis of three years data shows clearly that there is a relative increase in cost of managing diabetes patient for every 1% rise in A1C level. These costs were noted to be even higher in diabetes patients with heart diseases (Gilmer et al., 2005).

Self Blood Glucose Management (SMBG)

SBGM is another important blood glucose monitoring tool that is commonly used for monitoring glycemia or blood glucose level (Berard, 2013). It plays a vital role in diabetes management especially in diabetes self care and treatment (Karter, Parker, & Moffet, 2006). Benefits of SBGM include:

1. It is the only available blood glucose testing method that can help a diabetic patient confirm and correctly treat hypoglycemia.
2. It can help patients know if their lifestyle modification and therapeutic treatment is yielding expected results.
3. It can also provide vital result to both clinicians and patients to aid in short or long-term modification and treatment decisions in individuals with type 1 or type 2 diabetes (Karter, Parker, et al., 2006).

Results from a study with a random sample of 6989 individuals with type 2 diabetes showed that participants that perform SMBG test were noted to have a lower A1C numbers (8.1 +/- 1.6) when compared to the control group that had a higher AIC level (8.4+/-1.45, *P* 0= .012). This result indicates that a better glycemic control is associated with SBGM (Guerci et al., 2003). Data from a large cohort study indicated that for individual with type 1 diabetes, performing SMBG three or more times a day resulted in 1.0% decline in A1C (Consensus Committee of American Diabetes Association et al., 2007). Also a nonrandomized trial shown that performing SGBM for at least three times daily resulted in better glycemic control in type 2 diabetic patients that are on insulin (Sheppard, Bending, & Huber, 2005). The number of times that SMBG must be performed is individualized according to each patient's particular need. Factors that normally determine the numbers of times a patient should perform SBGM include nature of therapy; satisfactoriness of blood glucose control; education and ability to read numbers; potential for hypoglycemia; knowledge about hypoglycemia; nature of job; and acute illness (Berard et al., 2013). In a survey conducted in United Kingdom to gauge the views of type 2 diabetes patients on the benefits of SMBG in diabetes management. Investigators specifically asked study participants to indicate the benefits that they derive from SMBG and specify how they were able to achieve them. Results from the survey showed that 80% of the study participants reported that they were highly satisfied with SMBG and they also reported that they feel more in control of their disease (Barnard, Young, & Waugh, 2010). In spite of the benefits from SMBG, many individuals are very

uninterested in self-monitoring their glucose levels because of a few obvious problems associated with SMBG. Some of these problems include pain at injection site, patient denials of their condition, discouragement, high cost of blood glucose test meter and strips (Barnard et al., 2010). A longitudinal research conducted with 18 type 2 diabetes patients to determine patients perspectives on performing SMBG over time, shows that diabetic patients reduces their frequency of performing SMBG with time because of lack of encouragement from their healthcare providers, decline in interest for self-monitoring, difficulties in interpreting meter readings, lack of adequate knowledge on how to respond appropriately to meter reading were some of the identified reasons why some patient are unable to take full advantage of the benefits of SMBG (Peel, Douglas, & Lawton, 2007). SMBG have been shown to be most beneficial when implemented alongside with educational program that promotes behavioral changes such as lifestyle changes with or without hypoglycemic agents in response to changes in blood glucose results (Polonsky, Fisher, & Schikman, 2011). Diabetes education programs also teach patient the right methods of performing blood glucose test, recording test, interpreting blood sugar readings and how to make informed decision (Canadian Diabetes Association, 2013). Failure to perform SMBG as recommended could lead to wrong adjustment of medication dosage, nutrition modification and physical activities that are crucial for the achievement of glycemic target (Jordan & Jordan, 2010).

Diabetes Screening

The A1C and the fasting blood glucose (FBG) tests are used in Canada for type 2 diabetes screening (Ekoé, Punthakee, Ranson, Prebtani, & Goldenberg, 2013). Unlike many other chronic diseases, the method for diagnosis and screening for diabetes are the same for diabetes. However, the A1C test is not a recommended diabetes diagnostic test for children, people with advanced liver or kidney disease, those with type 1 diabetes, patients that are older than 65 years and in individuals with abnormal hemoglobin (Goldenberg & Punthakee, 2013). Diabetes screening means testing for diabetes in people that are not aware that they have diabetes. Screening for type 1 is not generally recommended because unlike type 2 diabetes, there are presently no proven interventions to delay its onset or prevent the disease (Canadian Diabetes Association, 2013; Ekoé et al., 2013). The percentage of adults with undiagnosed type 2 diabetes could be greater than 10% in some populations (Rathmann et al., 2000; Rolka et al., 2003). Apart from helping to diagnose and identify individuals with diabetes, screening assist healthcare practitioners to identify individuals that are at a low or high risk of becoming diabetic (Cowie et al., 2002; Knip et al., 2010). In a study conducted in Canada to investigate the prevalence of undiagnosed diabetes and sugar intolerance, 9042 individuals of 40 years and over were recruited for the investigation. Patients with causal prink glucose reading greater than 5.5 mmol/l were asked to do the FBG. And if the FBG test result was 6.1–6.9 mmol/l, a 2hPG in a 75 g OGTT test was ordered. Results from these various tests were used to allocate patients into the different diagnostic groups. The data from this study

show that 2.2% of participants had undiagnosed diabetes, Glucose intolerance were identified in 3.5% of study participants and 16.4% of participant were previously known to be diabetic. The finding of this study support and justify routine screening for diabetes in individual that are ≥ 40 years old every three years in Canada (Leiter et al., 2001).

Diabetes Risk Factors

Presently, all the risk factors that are responsible for the development of type 1 diabetes are not fully known (Canadian Diabetes Association, 2013; Public Health Agency of Canada, 2013). Nevertheless, investigators agreed that interaction between environmental factors and acquired genes are responsible (Beyhan & Leslie, 2008; Public Health Agency of Canada, 2011). Obesity is commonly regarded as the most important risk factor responsible for the increasing incidence of type 2 diabetes (Hramiak, Leiter, Paul, & Ur, 2007; Morrison & Chanoine, 2007). Apart from being the most important risk factor for the increasing rate of diabetes, obesity is also a risk factor in several other chronic diseases such as cancers, breathing disorders, Heart diseases, arthritis, sleep and depression (Hramiak et.al, 2007; Morrison & Chanoine, 2007). The numbers of individuals that are obese in Canada is on the increase (Shields et al., 2010). According to Wing (2000), 80% to 90% of patients with type 2 diabetes are either obese or overweight. Also obesity is noted to be prevalent in people with type 1 diabetes (Conway et al., 2010).One study has shown that about one-quarter of Canadians are obese (Shields et.al, 2010). In a study conducted to determine the trend of obesity in Canada, investigators calculated Body mass index (BMI) for individual who are ≥ 18 years old that were not

residence in a long-term care. Investigators utilized information from Canadian health surveys conducted between 1985 and 2011. The results of the study were categorized into the following classes of weight: normal (BMI 18.5–24.9), overweight (25.0–29.9), obese class I (30.0–34.9), obese class II (35.0–39.9) and obese class III (≥ 40.0). The investigators used outcome measurement to determine prevalence of adult obesity based on weight categories. They estimated future adult obesity with the aid of regression analysis. Their findings show that adult obesity prevalence climbed from 6.1% in 1985 to 18.3% in 2011. The investigators also noted an increase in obesity prevalence in classes 1 to 111 weight categories between 1985 and 2011. The authors projected that by 2019, about half of Canadian provinces will have more obese and overweight adults than those with normal weight (Twells, Gregory, Reddigan, & Midodzi, 2014). Obese adults are up to four times more likely to develop type 2 diabetes than individuals who are not obese (Public Health Agency of Canada, 2011). In a systematic review and meta-analysis research conducted in Canada to determine the incidence of comorbidity associated with overweight and obesity, the authors did an in-depth literature search for several comorbidity associated with obesity and overweight in Canada with the aid of Medlin and Embase search engines. They extracted 89 studies that met their inclusion criteria (prospective cohort studies that have adequate sample size and report estimates that are based on the disease incidence). The researcher identified 18 different comorbidities that were associated with obesity and satisfied the study comorbidity inclusion criteria. The results of the meta-analysis show a significant statistical relationship between overweight

and the incidence of the following: type 2 diabetes, all types of cardiovascular diseases (with exception of congestive heart failure), gallbladder disease, chronic back pain, osteoarthritis, asthma, and all cases of cancer (with the exception of prostate cancer in males and esophageal cancer in females). The strongest relationship was noticed between overweight and the incidence of type 2 diabetes in females (RR3= .92 (95% Cl: 3.10-4.97). In addition, the results of this study also show that there is a significant statistical relationship between obesity and the incidence of the following: type 2 diabetes, all cardiovascular diseases (with exception of congestive heart failure), gallbladder disease, chronic back pain, osteoarthritis, asthma, and all cases of cancer (with the exception of prostate cancer in males and esophageal cancer in females).Obesity was also noted to be strongly related with type 2 diabetes incidence in females (12.24 (9.03-17.06)) (Guh et al., 2009). The study concluded that obesity and overweight are related to the incidence of several chronic diseases including type 2 diabetes. Apart from overweight and obesity, other diabetes risk factors in Canada include lifestyle, environmental, economic, genetic and social factor. Also important are physical inactivity, ethnicity, old age, pregnancy, and family history, smoking and residing in rural area (Public Health Agency of Canada, 2011).

Complications of Diabetes Mellitus

In spite of the multidiscipline approaches implemented to manage diabetes mellitus, the illness can still lead to several types of complications (Public Health Agency of Canada, 2011) The short-term complications associated with diabetes includes;

diabetic ketoacidosis (Public Health Agency of Canada, 2011); slow healing of bruises and cuts (Argenta & Morykwas, 2004); recurrent bladder and skin infections (Argenta & Morykwas, 2004). These short-term complications can lead to life threatening situation if not quickly managed (Public Health Agency of Canada, 2011). Diabetes is known to increase the potential of developing cardiovascular disease in diabetic individuals — a condition that include heart disease, stroke, and peripheral vascular disease (Public Health Agency of Canada, 2011). People with diabetes are two to four times more likely to have cardiovascular disease compared to people without (Booth, Kapral, Fung, & Tu, 2006). Cardiovascular diseases are the principal cause of death in people with type 2 diabetes and also the main reason for the high healthcare for Canadians living with diabetes (Simpson, Corabian, Jacobs, & Johnson, 2003). Mental disorders, including major depressive disorder, eating disorders and generalized anxiety disorder, are more common in individual with diabetes when compared to people without diabetes. Individual with psychiatric disorder and diabetes have reduced medication compliance, decrease adherence to planned diabetes self-care, higher levels of functional impairment (Canadian Diabetes Association, 2013). Apart from cardiovascular diseases and mental disorders, other long-term complications associated with diabetes include diabetic retinopathy, which results in damage to retinal blood vessel and thus can lead to loss of vision or impairment (Canadian Diabetes Association, 2013, Public Health Agency of Canada, 2011; Wong & Klein, 2008); diabetic nephropathy, which results from damage to kidney blood vessels by high blood sugar, potentially resulting in kidney failure

(Canadian Diabetes Association, 2013; Lok, Oliver, Rothwell, & Hux, 2004; Public Health Agency of Canada, 2011); and nerve damage, resulting from damage to the blood vessels by high blood glucose levels, which then leads to low blood flow to the nerves and subsequent nerve damage. Damage to nerves causes numbness, tingling pain, delayed gastric emptying, foot ulceration, foot amputation, and erectile dysfunction (Public Health Agency of Canada, 2011); gingivitis and periodontitis, two of the common dental conditions associated with diabetes patients (Lamster, Lalla, Borgnakke, & Taylor, 2008); congenital malformations (Allen et al., 2007); and lung diseases, including asthma, pulmonary fibrosis, pneumonia, and chronic obstructive disease (Ehrlich, Quesenberery, Van Den Eeden, Shan, & Ferrara, 2010).

Diabetes in Canada

There are more than 20 individuals diagnosed of diabetes every hour in Canada (Canadian Diabetes Association, 2009). The rising prevalence of diabetes is noted almost in every province in Canada including in Ontario where the city of Cambridge is located (Public Health Agency of Canada, 2011). Lipscombe & Hux (2007) conducted a study in Ontario to determine trends in mortality and prevalence of diabetes from 1995 to 2005 and diabetes incidence from 1997 to 2003 in individuals that are ≥ 20 years old. The investigators used population-based data, in addition to valid diabetes databases obtained from the province of Ontario. The results show that prevalence of diabetes climbed from 5.2% in 1995 to 8.8% in 2005. Prevalence was also noted to rise from 6.9% in 2000 to 8.8% in 2005. Prevalence rate was noted to be consistently higher in individuals ≥50

years old (7.1% of 3,675,554) when compared to people in the age range of 20 to 49 years old (3.5% of 5,601,391).The younger population shows the greatest increase in rate of diabetes occurrence (94% vs 63%, $p < 0.0001$). The incidence of occurrence increased to 8.2 per 1000 in 2003 from 6.6 per 1000 in 1997, showing that over a period of six years, there was a yearly 31% increase in incidence of occurrence of diabetes. Also, from 1995 to 2005, mortality rate was noted to fall by 25% in individuals with diabetes (Lipscombe & Hux, 2007). The results of a study conducted to ascertain diabetes prevalence in Canada in 2004 by Canadian primary care sentinel surveillance network put diabetes prevalence in Canada as 7.2%. In this study investigators analyzed medical records of 272,469 diabetic patients. Participants were 10 years and older and had visited a primary healthcare provider within the last two years before the study. The results also show that patient with diabetes see their healthcare providers about 1.42 times more compared to those individuals who are not diabetic (95% CI 1.42 to 1.43,) and also that patient with diabetes have 1.29 more of other medical conditions compare with individuals that are not diabetic (95% CI 1.27 to 1.31, p less than 0.0001) (Greiver et al., 2014).

The observed total direct and indirect cost for diabetes management in Canada in 2010 was $11.7 billion. This cost is projected to increase to $16 billion by 2020. This increasing cost is threat to Canada's future economic prosperity and healthcare system sustainability (Canadian Diabetes Association, 2011).

The direct cost includes cost for treatment, care, rehabilitation, hospitalization, institutional care, primary care (family physicians and specialist) and medications. Indirect cost includes economic cost related to loss as result of illness, injury associated disability and premature death (Canadian Diabetes Association, 2009). Although the numbers of Canadian with diabetes is huge, it is estimated that about 700,000 individuals with diabetes do not know that they have diabetes (Canadian Diabetes Association, 2009).The medical cost incurred on individual with diabetes is three times more than on people without diabetes (Canadian Diabetes Association, 2009). The estimated direct cost for medications and diabetes supplies for managing an individual with diabetes could cost from $1,000 to $15,000 annually (Canadian Diabetes Association, 2009).

Diabetes Management

Diabetes is a chronic illness requiring self-care. Effective diabetes self-management is vital to optimal control of blood sugar levels and prevention of diabetes complications (Canadian Diabetes Association, 2013; Watkins & Connell, 2004). Adherence to diabetes self-care behavior prevents the development of complications. Diabetes self-care behavior includes; adequate nutrition, physical activities, foot care, self blood glucose monitoring and medications adherence (Chatterjee, 2006; Poskiparta et al., 2006; Xu et al., 2010). The risk of diabetes complications decreases by about 43% by doing recommended physical activities, eating a proper diet, and maintaining the right weight (Lindström et al., 2006). Despite all the benefits that are obtainable from diabetes self-care managements, a significant percentage of diabetes patients fail to adhere

diabetes self-management plan (Jordan & Jordan, 2010). Statistical analysis for the year 2000—the Behavioral Risk Factor Surveillance System (BRFSS) data of 11,674 diabetes patients—shows that only about 50% of the patients tested their blood glucose levels as recommended (Nelson, Reiber, et al., 2002).One Finnish study reported that up to 19% of diabetes patient failed to engage in diabetes self-care behavior (Toljamo & Hentimen, 2001).

Diabetes and Physical Activities

Physical activity or exercise is an important integral in diabetes management. Studies have shown that physical activities assist individuals with diabetes to achieve the following; better glycemic control, reduced insulin resistance, sustained weight loss, increased strength, better blood pressure control and decrease need for diabetes medications (Chudyk & Petrella, 2011; Sigal et al., 2013). Resistance exercise complemented with regular aerobic exercise has been shown to significantly reduce A1C in addition to reducing body fat (Church, Blair, & Cocreham, 2010; Sigal et al., 2013). Current Canadian diabetes management guidelines recommend that individuals with diabetes should involve in aerobic exercise of moderate to vigorous intensity for up to 150 minutes each week, (Sigal et al., 2013). In addition to aerobic exercise diabetes patients are advised by the guideline to engage in resistance exercise at least twice every week (Sigal et al., 2013). The guideline recommended that physical activities or exercise should be supervised by experts because meta-analysis of trials that evaluated the benefits of physical activities reported that supervised exercises were more effective and showed

more beneficial effect on A1C, body resistance to insulin and weight than exercises with less supervision (Gordon, Benson, Bird, & Fraser, 2009).

Despite the fact that engaging in physical activity is beneficial for patients with diabetes, many diabetic patients still do not engage adequately in physical activities. Nelson, Reiber, et al. (2002) reported that in the United States only about 31% of patients with type diabetes engage in regular physical exercise and also that 38% of patient with type 2 diabetes indicated that they engage in less than recommended physical activities. Also another study indicated that only about 37.7% of diabetic patients engage in regular exercise (Safford et al., 2005). Patients indicated that that they find it difficult to adhere to prescribed physical activities because of the following reasons; fear of low blood glucose (Dubé, Valois, Prud'homme, Weisnagel, & Lavoie, 2006), risk of high blood pressure (Sigal et al., 2003), poor health, poor eyesight, falling/stumbling, and fear of been attacked by criminals (Belza et al., 2004).

Pharmacotherapy

Adherence to prescribed medication is a key factor that determines good therapeutic outcomes in diabetes patients (Fedrick & Justin-Temu, 2012; McGibbon, Richardson, Hernandez, & Dornan, 2013; Sweileh et al., 2004). Results from several studies have suggested that fewer risks of undesirable outcomes are noticed when patients take their medications as prescribed (Granger et al., 2005; Horwitz et.al, 1990; Simpson, Eurich, et al., 2006). In spite of great innovation and tremendous advancement in the diagnosis and management of diabetes, most diabetes patients still fail to adhere to

prescribe diabetes treatments (Fedrick & Justin-Temu, 2012; Sweileh et al., 2004). Data from a retrospective cohort research that investigated adherence to pharmacotherapy therapy by type 2 diabetes patients shows that 37% of patients stopped taking their medications about 12 months after their first diabetes medications, about 10.5% refused to refill their medications after their first diabetes prescriptions and approximately 46.2% of the participants were nonadherent to their medications (Hartz et al., 2006). Insulin regimens (Basal-bolus) are the main therapeutic agent use for the management of with type 1 diabetes. Insulin regimens are normally administered several times during day and in some cases the insulin is infused continuously through the subcutaneous (McGibbon et al., 2013). For patients to benefit maximally from insulin therapy there is the need to tailor regimen to patient's treatment goals, way of life, eating habit, health status, enthusiasm, knowledge about hypoglycemia and self-management capability (McGibbon et al., 2013). Treatment or management of type 2 diabetes are generally individualized because most patient with type 2 diabetes have different needs and each of them have to be treated according to their needs and severity of their diabetes. Individuals with type 2 diabetes experience a gradual decrease in the amount of insulin produced by the beta cells of the pancreas as the disease progresses, and as result management must be dynamic to accommodate this gradual decline in insulin (Harper et al., 2013). Medications used for managing diabetes are varied and as result the following important factors are important to be considered when choosing hypoglycemic agents; patients ability to comply with medication regiment, medication side effects, medication efficacy especially ability to

reduce diabetes complications, presence of other medical conditions, potential of medication to cause hypoglycemia (Harper, 2013). The CDA has a published consensus guideline for the management of hyperglycemia in patients with type 2 diabetes. According to the guideline, management begins with lifestyle modification (which includes physical activity and nutritional therapy) with or without drug therapy. If glycemic control or target is not achieved at two to three months of lifestyle intervention, suitable therapy such as metformin is either included or increased in order to attain target (Harper et al., 2013). And if, after three to six months of inclusion of metformin, target is still not achieved, another agent that best suits the patient is added to the medication regimen. Adjustment to and or addition to medication regimen continues until target is achieved (Harper et al., 2013). The guideline recommended that if A1C is greater or equal to 8.5% at the time of diagnosis, suitable drug therapy such as metformin along with lifestyle intervention must be initiated. It is recommended that under this situation inclusion of insulin therapy alongside metformin should be considered. And if target is not achieved in three to six months, adjustment or addition to medication regimen is recommended until target is achieved (Harper et al., 2013). If patient shows clear symptoms of hyperglycemia plus obvious sign of metabolic decomposition at the time of diagnosis, management under that situation will include the immediate initiation of insulin therapy with or without metformin and if target is not achieved within three to six months another hypoglycemic agent that is suitable to patient have to included.

Adjustment to medication regimen is recommended until target is achieved (Harper et al., 2013).

Nutrition

The overall objectives of nutritional therapy are to sustain or advance better quality of life and prevent complications and other disorders associated with diabetes (Dworatzek et al., 2013). Nutritional therapy which is a very important component of diabetes management have been documented by multiply studies to lower AIC by up to 2% (Dworatzek, et al., 2013; Gaetke, Stuart, & Truszczynska, 2006). Some studies have suggested that even better outcomes such as decreased rate of hospitalization are noticed when nutrition therapy is implemented concurrently with other methods of diabetic care (Imai, Kozai, & Matsuda, 2008; Robbins, Thatcher, & Webb, 2008). Also regular follow-up (i.e., once every three months) have been shown to be associated with better nutrition compliance in people with type 2 diabetes (Huang, Hsu, & Wang, 2010). Balanced diets that are low in calories have been shown to help in maintaining a better, healthier body and subsequently better glycemic control (Look AHEAD Research Group, 2010). The current CDA clinical guidelines for mutational therapy recommend that diabetes patients should eat from the different varieties of foods, from all four food groups, including grain products, vegetables and fruits, meat and alternatives, and milk and alternatives, while consuming more foods that are high in volume and low in calories. It also recommended that only between 20% to 30% of calorie of daily energy intake come from fat, 15% to 20% from protein, 45% to 60% from carbohydrates, and less than 7% from saturated fats.

Some studies have shown that diabetes patients find it difficult to adjust to diet change (Chowdhury et al., 2000; Nelson, Reiber, et al., 2002). Analysis of the NHANES III study by Nelson, Reiber, et al. (2002) showed that 61% of respondents derived more than 10% of their total daily energy intake from saturated fats, 42% of them obtained 30% to 40% of their energy intake from fat, 26% got more than 40% of their daily energy intake from fat, and 62% of the respondents reported not consuming up to five servings of fruit and vegetables daily (Nelson, Reiber, et al., 2002).

Weight Management

Weight management is another important integral in diabetes management. About 80% to 90% of patients with type 2 diabetes are overweight (Wharton, Sharma, & Lau, 2013). The main objective for the treatment of overweight and obesity in individual with diabetes is to use health behavior intervention to attain best possible metabolic and glycemic control. Health behavior interventions that are composed of dietary adjustment, improved and more frequent physical activity in addition to behavior therapy have been demonstrated to be very effective (Wharton et al., 2013; Wing et al., 2001). Studies have shown that a moderate loss of 5% to 10% weight can significantly result in better sensitivity to insulin, blood glucose control, dyslipidemia, and blood pressure (Wharton et al., 2013). The Look AHEAD Research Group (Action for Health in Diabetes; 2010) study sponsored by the National Institutes of Health was designed to study how lifestyle intervention affects alteration in weight, physical fitness, cardiovascular events and risk factors in individuals living with diabetes. Data gathered from the first and fourth year of

this multicenter study indicated that a 5% to 10% loss in weight produced significant health benefits in the study participants, these benefits includes better glycemic control, lower lipid profile, decrease blood pressure and reduction in cardiovascular events and risk factors (Look AHEAD Research Group, 2010; Wharton et al., 2013).

Literature Review Related to Study Methodology

This research is a quantitative research that will use a cross-sectional design method to evaluate factors related to diabetes medication adherence in Cambridge. According to Frankfort-Nachmias & Nachmias (2008), cross-sectional design is a prominent design method in several social science studies. Fedrick & Justin-Temu (2012) conducted a cross-sectional study to determine the factors associated with nonadherence to medications by diabetes patients in the city of Mwanza, Tanzania. The authors specifically investigated the association between nonadherence and several variables which included alcohol consumption, distance of clinic to patient's home, medications side effects, knowledge relating to diabetes treatment and related complications. The total numbers of diabetes patients interviewed in this study were 272. Respondents, 43.4% of whom were males, were selected from two diabetes clinics in Mwanza. The average age of participants was 51.22. The authors of this study fail to indicate how they calculated their sample size and also did not state the limitations of this study. The results of this research showed that 98% of the respondent claimed that they are very well informed about diabetes and diabetes management, thus eliminating diabetes knowledge as a possible factor that contribute to nonadherence. However, 28% of participants reported

that they did not adhere to their diabetes medications. Medication adverse effects, alcohol consumption, and long distances between patients' home and clinic location were noted to be the important variables that contributes to nonadherence in this study ($p = 0.001$). The authors of this study maintained that nonadherence to prescribed medications was the reason for poor health outcomes among diabetic patients (Fedrick & Justin-Temu 2012).

Sweileh et al. (2014) conducted a cross-sectional study to investigate the influence of belief, diabetes knowledge on adherence to diabetes medication. This study was conducted in Palestine, in a primary healthcare diabetes clinic located at Nablus. In this study, the Morisky instrument (MMSA-8©) was used to determine medication adherence. Knowledge related to diabetes was determined with the aid of the Michigan Diabetes Knowledge Test and beliefs related to the necessity of medications were assessed with the aid of structured questionnaire. SPSS 20 was used for multivariate and univariate analysis of data. The numbers of respondent included in this study were 4007 diabetic patients. Their age range was 28 to 90 years old. Percentage of females was 53.3%. The average standard deviation of age of respondents was 58.3 ± 10.4. Data from this study shows that about 42.7% of research sample were nonadherent (MMAS-8© score of < 6). Also, the results of this study indicated that the following factors were significant contributors to nonadherence; diabetes-related knowledge, beliefs related to the need for diabetes medications, concern about implication of side effects from diabetes medications and general beliefs that medicines causes harm. Study participants with high knowledge about diabetes and those that belief strongly in the benefit of their diabetes

medications were more likely to be compliant ([O.R = 0.87, 95% CI of 0.78–0.97] and [O.R = 0.93, 95% of 0.88–0.99], respectively). Nonetheless patients that were very concern about the consequences of the side effects of diabetes medications and those that have strong belief that medications are generally harmful were less likely to adhere to their medications ([O.R = 1.09; 95% C.I of 1.04–1.16] and [O.R = 1.09, 95% C.I of 1.02–1.16] respectively). Limitations of the study include the following; firstly, the self-report method used for assessing medication adherence could results in overestimation of adherence to medications. More reliable estimates of adherence could be obtained by direct methods. Secondly, the Validity of the Morisky Medication Adherence Scale (MMSA-8©) Arabic version used for this study have not been ascertained, consequently this could lead to incorrect conclusions. Thirdly authors of this study are of the view that the sample size is not large enough to represent the Palestine population, fourthly since no A1C data was used in this study, it not possible for the authors to link glycemic control with knowledge, belief and adherence (Sweileh et al., 2014).

Gelaw et al. (2014) conducted a descriptive cross-sectional study in Ethiopia to examine the extent and factors promoting nonadherence among diabetics who attended Adama Referral Hospital diabetes clinics. Participants numbered 270, and were 18 years old and over. The study response rate was 98.3%, of whom males constituted 51.5%, and the percentage of married individuals in the study was 68.1%. Participants that were less than 40 years of age made up 14% of study of the group and 50% of the participants were between 40 and 60 years old. Selection was done by choosing every other patient and

structured questionnaire was used to obtain information regarding adherence to medications. Version 16 of predictive analytical software was used for data analysis and management. Descriptive statistics was used to analyze sociodemographic data, and logistic and correlation analyses were also conducted in this study. Gelaw et al. (2014) failed to indicate the limitations of this study and the ethnicity of study participants were not revealed. Results from the study show that 21.1% of the study participants blamed their nonadherence on forgetting to take their diabetes medications. Participants with diabetes history of five years and below (82.07%) were noted to be more compliant to taking their medications while individuals with diabetes duration of more than five years (60.8%) were less compliant. The investigator stated that this difference was significant ($P = 0.003$). Hypertension (54.84%) and eye impairment (32.96%) were noted to be commonly associated with diabetes. The percentage of female patients who adhered to their diabetic medications was noted to be higher (74.81%) when compared to the male patients (69.78%). This difference was noted by the investigators as not statistically significant ($P > 0.05$). The authors concluded that poor glycemic control among participants was mainly due to poor adherence to recommended medication regimen, poor knowledge about diabetes, inadequate knowledge about diabetes management and failure to practice diabetes self-management (Gelaw et al., 2014).

A cross-sectional prospective research was conducted by Nozaki et al. (2009) to determine the relationship between glycemic control and psychological factors. The authors used psychological tools to measure this relationship. The method of analysis was

multiple regression analysis. A total of 304 diabetes participants that regularly visit an out-patient clinic for treatment were engaged for this study. Respondent were made to take the A1C test at the start of the study. Respondent were also made to complete the following self-report psychological inventories: Well-Being Questionnaire 12 (W-BQ12), Diabetes Treatment Satisfaction Questionnaire (DTSQ), Social Support Scale, Self-Efficacy Scale, Self-Esteem Scale (SES), Social Support Scale and Problem Areas in Diabetes Survey (PAID). Information regarding participant's age, medical history was also collected. Results from data analysis shows that there is a statistical significant relationship between diet management, microvascular problems of diabetes Type II, age, and the scores from the PAID, SES, DTSQ, self-efficacy scale and W-BQ12. Participants A1C were again measured after one year. Multiple regression analysis was used to analyze the data of 219 respondents (95.4% of the 304) after one year. The results shown that PAID and DTSQ predicted a lower medication adherence and glycemic control. Limitations of this study included: self-management and self-care were not correlated with adherence to medication; and 14 of the study's respondents were not followed and four of them passed away during the study. The authors were of the opinion that the 14 patients may have been more dissatisfied with their management plan. The authors were unable to determine if there were any similarities or difference between psychosocial or sociodemographic variables after one year. The establishment of a correlation between patient satisfaction and glycemic control is a major strength of this study. Patient satisfaction means a better quality of life. Respondents that were satisfied had no problem

adhering to their healthcare providers' treatment plans. In their conclusion Nozaki et al. (2009) recommended that more multiple regression analysis investigations that include the following variables; age, gender, socio-demographics, and quality of life satisfaction are needed in future (Nozaki et al., 2009).

Khan et al. (2012) conducted an investigation to identify factors promoting noncompliance among diabetes patient in Saudi Arabia. In this cross-sectional study conducted in Al Hasa community of Saudi Arabia, the authors used random sampling technique to select 535 diabetes patients from three chronic disease clinics. Data were collected from patient's clinic file records and interview questionnaires. This study started on June 2010 and ended on June 2011. The numbers of individuals that finally participated in this research were 468 diabetic patients. 67 declined, resulting in 87.47% response rate. Participants who were selected were those that have had diabetes for at least one year. Most had been on the same diabetes medications for not less than six months, had been prescribed adequate doses of diabetes medications, and had been well-educated on diet and physical activities. Patients who failed to follow medical directives and had A1C that is greater than 7% during the time of interview were regarded as noncompliant. The following data were collected for this study: age; level of education; marital status; gender; duration of diabetes; name of other chronic diseases; disease control status; numbers of medications that a patient was taking; frequency of follow-up with doctor; and adherence to medication. Statistical calculations were done with the aid of version 13 of SPSS. Khan et al. (2012) failed to indicate the limitations of this study

and also did not show how they calculated the study sample size. Results of this study show that the total prevalence of medication noncompliance among study participants was about 67.9% (*n* = 318, 95% CI 63.59–72.02%). The prevalence of noncompliant females (65.45%, *P* =.003) was lower than males (69.34%). The noncompliance observed among those who lived in rural areas was significantly lower than among those who lived in an urban area (60.15% vs 71.04%, *p* = 0.023). Education was also noted to influence noncompliance. Bivariate analysis shows that factors significantly linked with noncompliance include: education status (*OR* = 5.27, CI = 4.63–7.19), female gender (*OR* = 1.90, CI 1= .32–4.57), living in urban area (*OR* 5= .22, CI= 3.65–8.22), inconsistent follow-up (*OR* = 8.41, CI = 4.90–11.92),), not taking medications as prescribed (*OR* = 4.55 , CI = 3.54–5.56), not adhering to exercise plan (*OR* = 5.55, CI = 4.2 6–6.), using insulin (*OR* = 1.29, CI = .71–1.87) and taking metformin and insulin concurrently (*OR* = 1.20, CI = .65–1.75) (Khan et al., 2012).

Boswell, Cook, Burch, Eaddy, and Cantrell (2010) conducted a systematic review of several original articles that investigated adherence to medications, economic, clinical recommendation and/ or use outcomes. The original articles selected for this research were studies that concentrated on the North American population. The 13 chronic diseases selected for this study were: coronary artery disease (CAD), type 2 diabetes, hyperlipidemia, chronic obstructive pulmonary disease (COPD), heart failure (HF), asthma, hypertension, postmyocardial infarction (post-MI), seizures, bipolar disorder, migraine, depression, and schizophrenia. In this study the researchers' variables of

interest included adherence, costs, outcomes, hospitalization, economics, and Medicaid and prescription drugs. Data used for this research were collected from 1974 to 2010. The authors reviewed 105 primary articles that investigated various chronic diseases except migraine. The authors noted 100% outcomes in the relationship between adherence and clinical outcome in post-MI, depression, schizophrenia and seizures. COPD was reported to have a neutral outcome in the association between adherence to medication and clinical outcome, about 75% of outcomes was noted in the relationship between clinical outcome and adherence in all the other disease state apart from hypertension that demonstrated 64% outcome. In economic outcomes, the authors also reported 100% of outcomes in the association between adherence to medication and economic outcomes in hyperglycemia and CAD. Results of outcomes for seizures, post-MI was not available. HF, asthma, and COPD had the lowest relationships between economic outcomes and adherence, and for the remaining five disease states, about 50% of outcomes were linked to adherence. For utilization outcomes, the authors reported a 100% outcome in the association between adherence and use outcome for schizophrenia, post-MI disease states and about 75% of use outcome were linked to adherence in hyperglycemia, CAD, depression, bipolar disorder and seizures. Boswell et al. (2012) showed from their study that medication adherence is an important variable that predict economic, utilization and clinical outcome in individuals with chronic diseases, though, outcomes was noted to differ across the different disease groups. Limitations of this study included lack of literatures on medication adherence in migraine management. Also, only very few

literatures relating to some of diseases of interest were available, this consequently prevented an in-depth evaluation of adherence and health outcome in COPD and seizure. Furthermore, researchers focused mainly on individual outcomes instead of holistically evaluating the consequence of medication adherence and how to promote adherence. Boswell et al. suggested further future research including independent variables that specifically addressed particular chronic disease, such as type 2 diabetes.

Crossman, Nguyen, Slavik, & Allan (2008) conducted a study to determine the number of patients visiting the Lion Gate Hospital Diabetes Center for whom medication therapy, laboratory targets, and monitoring frequencies were achieved as recommended by the CDA clinical practice guidelines of 2003. Consecutive individuals with type 2 diabetes were selected and added as study participant. Of the total of 349 type 2 patients selected for this study, only 48% of this number met the inclusion criteria. Medical records of participates were reviewed and the age range o participants was 19 to 69 years. Data were tabulated using Microsoft Excel 2000. Standard deviation or the root-mean-square deviation and the means were recorded as normally distributed data while the interquartile range and median were recorded as skewed data. The results of data analysis showed that for the majority of the patients, the recommendation for monitoring frequencies were achieved, but recommendation for appropriate medication therapy and laboratory targets were not met. The most important strength of this research was its broad appraisal of a wide selection of diabetes management quality Indicators which included medication use, laboratory targets and monitoring frequencies. The researchers

also stated that this is the only study that has that evaluated adherence to the 2003 Canadian diabetes clinical practice guideline. Unfortunately, the fact that this was a retrospective design, this research, did not identify the main reasons for poor adherence to laboratory targets and medication prescription criteria's in this population of patients. Another limitation was the lack of control group which would have enables true comparison of the study and the control groups. Authors also reported limited access to laboratory results which could have resulted in the wrong estimation of laboratory frequencies. Self- reporting of pharmacological therapies could have result in the low estimation of medication usage (Crossman et al., 2008).

For the past 15 years the CDA has relentlessly tracked the amount individual diabetic patients spend on medications, strips and devices by using type 1 and type 2 diabetes composite case studies. The result of the study shows that 57% of diabetes patients in Canada reported that they find it difficult to adhere to their recommended treatment plan as a result high out-of-pocket cost needed for medications, supplies and devices. The authors of the study noted that the high out-of-pocket cost is due to less access to both public and private insurance (Canadian Diabetes Association, 2015). In Canada studies relating to diabetes care and adherence to diabetes medications are scanty. Cross-sectional and retrospective data shows that there is a low adherence to the Canadian diabetes guideline for diabetes management (Crossman et al., 2008; Meltzer et al., 1998). Only about half of diabetic patients interviewed during a national population survey indicated that they saw their eye specialist in the previous year (James, Young,

Mustard, & Blanchard, 1997). Data relating to prevention and screening for other diabetes complications are hard to find. Although the national population survey data indicated a high rate of adherence to blood pressure screening, very few areas of diabetes care were examined (James et al., 1997).One retrospective research that had a small numbers of participants (n = 118) indicated that primary care practitioners and patients in Canada poorly adhere to Canadian diabetes clinical guideline or diabetes management, only 53% of patient show evidence of A1C test, 31% of patients adhere to foot care examination and 54% visited their eye doctor in the past year (Worrail, Freake, Keiland, Pickle, & Keenan, 1987). Large prospective studies on diabetes care are not available, and as a result it is difficult to make any definitive conclusions about diabetes care and adherence to medication in Canada.

Description of Independent and Dependent Variables

The objective of this research is to establish if there are factors associated with adherence to oral diabetes medications among type 2 diabetes patients in Cambridge by means of a quantitative design method. This study will explore the relationship between independent variables (age, gender, income, level of education and diabetes knowledge) and the dependent variables (adherence to diabetes medications) among individuals with type 2 diabetes in Cambridge.

Age Factor

Age has been shown to be an important factor in the development of type 2 diabetes (Canadian Diabetes Association, 2011b; Cuasay, Lee, Orlander, Steffen-Batey,

& Hanis, 2001). Elderly Canadian seems to be more likely to develop the disease; from 2005 to 2006, an estimated 1 in 5 (22%) of elderly Canadian were diagnosed with type 2 diabetes mellitus. This represent about 10 times the number observed among adults Canadians 35 to 39 years old, which had a prevalence of 2.3% or one in 47 (Canadian Diabetes Association, 2009; Public Health Agency of Canada, 2011). In a study conducted by in the United States by Cuasay et al. (2001) to determine the prevalence of diabetes among the different Filipino Americans age groups living in Houston, the authors used a sample size of 831 participants and study was conducted from September 1998 to March 2000. The results showed a prevalence of 34.2% among individuals aged 65 to 74 years compared to a prevalence of 5.6% observed among those that were 35 to 44 years old.

Several factors place older adult at risk for issues in diabetes medication management (Nikolaus et al., 1996). Seniors in the young-old age group (ages 66 to 74) have been noted to be more adherent to their medications when compared to the middle-aged older adults. After their 75th year, seniors show decreased understanding of medication instruction (Guo, Chang, Chang, Wang, & Yeh, 2008). Other factors that promote poor adherence in elderly include cognitive decline and poor vision, medication side effects and inadequate knowledge of the medication that they take (Nikolaus et al., 1996). Cramer (2004) and Garcia-Perez, Alvarez, Dilla, Gil-guillen, and Beltran (2013) noted from their studies that age was a strong determinant of adherence to diabetes medications. However some other studies reported that patient's age was not associated

with adherence or nonadherence to diabetes medication regimens (Khan et al., 2012; Nozaki et al., 2009). This study will nonetheless test the strength association between age and adherence to oral type 2 diabetes medication regimen in Cambridge.

Gender Factor

In Canada, the probability of developing diabetes mellitus rises with age, particularly after age 40, increasing from 4.6% of women and 6.3% of men aged 45 to 54, to14.8% of women and 22.1% of men aged 65 and older (Canadian Diabetes Association, 2011). In the first half of last century, type 2 diabetes was noticed to be more among the female population but now it is shown to be equally prevalent among women and men in most population, with some indication of male excess in early middle age (Gale & Gillespie, 2001).

Pond, Sturock, and Jeffcoate (1996) showed that diabetes control is better in men than in women at all ages from about 16 years onwards (Pond et al., 1996). This difference in adherence between men and women may be as a result of the fact that women more often have to cope with care of their family as well as their diabetes. However, Khan et al. (2012) showed from their study which evaluated several factors that promote adherence to diabetes medication that women were better adherers to diabetes medication than men. A cohort study conducted recently in Germany to evaluate the gender differences in relation to diabetes medication adherence and poor blood glucose control in type 2 diabetes patients showed considerable gender-specific differences in the relationship of adherence and poor glycemic control. Finding from this

study shows that 23% of men and 24% of females did not adherent to medication. In men, poor blood glucose control was noticed in 37% of the study participants reporting nonadherence to medication and in 19% of participant reporting adherence. Whereas, among the women, poor glucose control was noticed in 19% of the study participants reporting nonadherence to diabetes medication and in 18% of study participants reporting adherence (Raum et al., 2012). In a cross-sectional study conducted by Gelaw et al. (2014) in Ethiopia to examine the extent and factors promoting nonadherence among diabetics who attended Adama Referral Hospital diabetes clinics, the authors engaged a study sample of 270 participants. The result of the study shows that across gender, the rate of adherence differed, and females were more adherent, 74.81%, compare to males, 69.79%. This study will evaluate the strength of association between gender and adherence to diabetes medications in Cambridge.

Level of Education

Ability to read and understand the instructions of how to take prescribed medications is an important factor that promote adherence to medications; hence individual with higher education profile have the advantage of understanding prescription instructions with less difficulties. Gelaw et al. (2014) found a strong association between higher level education and adherence to diabetes medication. In their study, they noted a higher adherence rates among patients with diplomas (80.77%) and individuals with secondary school education (80%). In a cross-sectional study conducted in Eastern Uganda to determine the factors promoting adherence to diabetes medication, study

sample which was made up of 521 diabetes patients were recruited from Bugiri and Iganga hospitals. The study took place from October 2012 to January 2013. Participants were 18 years and older and have been on diabetes medication for not less than one month. Questionnaire used for the research was pretested. Variables that were tested included sociodemographic characteristics, and self-management efforts. The authors assessed adherence by using self reports. Inferential and descriptive statistics were conducted to evaluate adherence to diabetes medications and the related factors. The result of study shows that participant's sociodemographic characteristics such as sex, marital status and education level are not linked to adherence to diabetic medication (Bagonza, Rutebemberwa, & Bazeyo, 2015). This is in disagreement to the result of an adherence study conducted in Saudi Arabia by Khan et al. (2012). Although results from studies on the status of level of education on adherences are mixed, this study will however evaluate the effect of level of education on adherence to diabetes in Cambridge.

Diabetes Knowledge

Most patients with diabetes develop diabetes-related complications as a result of poor knowledge of the disease and inadequate insight about glycemic control. Patient education is one of the most effective ways of managing diabetes and reducing complications (Mulcahy et al., 2011). Al-Qazaz et al. (2011) conducted a cross-sectional research with a convenience sample of 540 adults with type 2 diabetes. The aim of the study was to determine the association between diabetes knowledge, medication adherence and glycemic control. The instruments used in included a questionnaire, a

validated Michigan Diabetes Knowledge Test, and the Morisky Medication Adherence scale. Patients' medical records were reviewed for disease-related information and glycosylated haemoglobin levels (HbA1C). The authors excluded 35 patients after data collection because of nonavailability of their HbA1C results. The result of their study shows a strong relationship between diabetes knowledge and medication adherence ($P < 0.05$) in patients with lower HbAIC levels. Also multivariate analysis shows that predictors of good glycemic control includes diabetes knowledge, higher adherence to medication and use of mono-therapy. The result of this study is in agreement with the results of the study conducted in Palestine by Sweileh et al. (2014). Colleran, Starr, & Burge (2003) conducted a study to test the association between diabetes knowledge and blood glucose control by using the Michigan Diabetes Knowledge Test to measure diabetes knowledge along with measuring patient's HBA1C. The results of their study showed that better diabetes knowledge scores were inversely related to lower HbA1C levels ($r = -0.337$, $P < 0.003$), signifying that higher knowledge scores positively impacted glycemic levels (Colleran et al., 2003)

Nonetheless, diabetes knowledge does not always guarantee the attainment of good blood glucose control. A cross-sectional study conducted in Shanghai, China by He and Wharrad (2007) among 60 outpatients and 40 inpatients showed that there was no significant difference in diabetes knowledge among participants for suboptimal or good blood glucose control. However, the result of the study shows a negative association ($r = -0.208$, $P = 0.038$) between age and diabetes knowledge. Also occupation associate

significantly with diabetes knowledge with those with white-collar jobs having the highest mean score (24.84) while the lower mean score (20.67) was recorded among the housewives (He & Wharrad; 2007).

Income

Paying for the needed supplies of medications for the management of chronic illness like diabetes involves huge financial commitment. Investigators have showed that patients inability to purchase diabetes medication play a vital role in adherence to diabetes therapies (Nagelkerk, Reick, & Meengs, 2006). Researchers have also found a significantly strong inverse relationship between out-of-pocket payment for type 2 diabetes medications and adherence to diabetes medication regimen (Karter, Ferrara, et al., 2000). Consequently, prescribing cheap and effective diabetes medication such as metformin could promote adherence to medication especially for individuals who are uninsured. The continued increase in the cost of medications can further enhance low adherence to medication regimen by individuals with chronic conditions including diabetes (Horswell, Wascom, Cerise, Besse, & Johnson, 2008). Sokol, McGuigan, Verbrugge, and Epstein (2005) showed that for hypercholesterolemia and diabetes optimal level adherence to medication regimens was linked to lower disease-associated medical cost in uninsured diabetes patients. Chernew et al. (2008) conducted a research to determine the consequences of increased patient's healthcare cost sharing on the various socioeconomic groups in healthcare. The objective of the study was to add to the body of studies on out-of-pocket expenses and adherence by exploring the association

between copayments and adherence to prescribed medications across the various income groups in the United States. The result of their study shows that individuals living in high income areas were more likely to adherence to their prescribed prescriptions in spite of increase in copayment or increase in medical share cost. However, the study indicated that adherence to medications was more likely to decrease when there is an increase in copay for medication among patients that are low income earners, this finding shows that a raise in patient out-of-pocket expenses for prescribed drugs can simply result in low adherence to prescribed medication among the poor. This study is in agreement with the results of an adherence study conducted in Ethiopia by Gelaw et al. (2014). In a study conducted in Canada to determine the impact of cost on medication adherence. The authors used data obtained from 2007 Canada community survey for their research. Responses of 5732 participants that answers question relating to cost-associated nonadherence to treatment were analyzed. The authors determined national prevalence of cost-associated nonadherence to treatment and logistic regression was used to evaluate the link between cost-associated nonadherence and several socioeconomic and demographic variables, including sex, age, province of residence, household income, having drug insurance and health status. Results of the study show that 9.6% (95% confidence interval [CI] 8.5%–10.6%) of Canadian reported that cost was the reason for their nonadherence to their medications. The study also shows that lower income (*OR* 3.29, 95% CI 2.03–5.33), poor health status (odds ratio [*OR*] 2.64, 95% CI 1.77–3.94), individuals without drug insurance (*OR* 4.52, 95% CI 3.29–6.20) and those residing in

British Columbia (*OR* 2.56, 95% CI 1.49–4.42) were more likely to report that cost is the reason for their nonadherence to prescribed medications. Predicted percentage range of cost-associated nonadherence is from 3.6% (95% CI 2.4–4.5) among individuals with drug plan insurance and household with high incomes to 35.6% (95% CI 26.1%–44.9%) among individual without insurance and household with low incomes (Law, Cheng, Dhalla, Heard, & Morgan, 2012).

Adherence to Type 2 Diabetes Medication

The dependent variable for this research is adherence to oral diabetes medications. Healthcare practitioners and investigators have proposed various definitions for adherence to treatment. Mihalko et al. (2004) defined adherence to therapy as the extent of involvement that is expected of a patient that have accepted a prescribed management regimen. Farmer et al. (2008) and Cramer (2004) defined adherence to treatment as an act of taking prescribed medications regimen as recommended or agreed between prescribed and patients. According to WHO (2003), adherence to therapy is "the extent to which a person's behavior-taking medication, following diet, and, or executing lifestyle changes, corresponds with agreed recommendations from a healthcare provider" (p. 3). For investigators to adequately measure adherence to treatment regimen, it is important to develop a consensus definition for adherence to therapy.

Optimal glycemic control of type 2 diabetes requires strict adherence to oral diabetes medications regimens (Canadian Diabetes Association, 2013; Khan et al., 2012). High level adherence is vital in preventing mortality, morbidity and maintaining adequate

glycemic control (Chernew et al., 2008). In some cases, higher adherence has been shown to result in even lower total healthcare expenditures (Sokol et al., 2005). In a quantitative research conducted by Schectman, Nadkarni, and Voss (2002) with 828 participants, the authors discovered that for every 10% rise in adherence to oral diabetes medication regimens, A1C reduced by 0.19% ($p < .0001$). Also Schectman et al. (2002) discovered a strong association over time between glycemic control and adherence to oral diabetes medication regimens. Similarly Harper et al. (2013) reported a direct relationship between adherence to oral diabetes medication and AIC values among Canadians. Investigators have shown that apart from resulting in poor disease outcome, low adherence to treatment is also a significant contributor to the increasing healthcare cost (Bartels, 2004; Guillausseau, 2005). Consequently, identifying factors that promotes adherence is vital for the development and implementation of strategies that will help promote adherence which will subsequently help to reduce diabetes-related mortality, morbidity, and healthcare cost.

Literature Review on Social Change

Investigators agree that adherence to diabetes medications help prevent diabetes-related complications (Canadian Diabetes Association, 2013; Watkins & Connell, 2004). Literature review shows that various factors are associated with adherence or no adherence to diabetes medications and these factors may differ across different communities and ethnic groups (Ciechanowski et al., 2001; Collins-McNeil et al., 2012; Marcum & Gellad, 2012; Peyrot & Rubin, 1994). Predictors related to diabetes adherence

or non adherence in Cambridge is not known. There is no doubt that adherence is an issue in Cambridge, because according to WHO about 50% of individuals with chronic diseases, including diabetes, do not adhere to their medications as recommended (Brown & Bussell, 2011; Reynolds et al., 2004**)**. Consequently, there is the need to identify those factors that influence diabetes adherence in Cambridge. Some of the merits of adhering to diabetes medication plan include: good quality of life, fewer diabetes-related complications, less financial burden on the patient and the health system, better glycemic control, and reduction of incidence of depression and anxiety among diabetes patient. This research will promote social change by assisting individual with diabetes to improve on their adherence to their medications and also this research will provide useful information that will assist healthcare providers to better understand diabetes, the reasons for nonadherence and how to better assist patient to adhere to their diabetes medication regimens. My aim also is to help provide information that will encourages policy makers at the regional and provincial levels to come up with policies and programs that will assist diabetes patient in Cambridge to overcome all the barriers that hinder adherence to medications and other treatment plans that can promote better quality of life. Assisting a diabetes patient to understand the barriers that are hindering them from adhering to their treatment plan is vital in the prevention and elimination of the said barriers (Swan, 2010).

Summary and Conclusion

This chapter contains the definition of diabetes, diabetes management methods and review of several adherence and nonadherence studies that were conducted to

improve management of diabetes around the world. This literature review section also included a synopsis of research designs and methodologies used in various adherences, nonadherence studies. Summaries of several theories that are related to medication adherence also formed a major part of the section. Also included in this section is a summary of the interventions targeted to improve adherence to diabetes management plans through patient participation in recommended physical activities, proper nutrition, weight management and health education. Chapter 3 contain in-depth description of research design, methodology, and recruitments of participants, sample size, ethical considerations and data analysis are provided. There is no information in the literature regarding adherence to diabetes medication in Cambridge.

Chapter 3: Research Method

There are no existing studies regarding adherence to diabetes medication regimens among diabetes patients in Cambridge . In this investigation I explored the factors that are linked to adherence to diabetes treatment in Cambridge using a cross-sectional approach. This chapter includes an in-depth description of study design, population, sampling method, instrumentation, organization of constructs, and ethical considerations related to participants. The chapter also contains the rationale for the selection of the quantitative study design used for this study. The participant recruitment method and the size and characteristics of the sample are presented in this chapter as well. The instruments used are described, as are the procedures for data collection and analysis. Threats to validity are presented at the end of the chapter.

Research Design and Rationale

A quantitative approach was used in this research to investigate the problem, which was low levels of adherence to prescribed diabetes treatment regimens in Cambridge. Investigators have identified that up to 50% of patients with chronic diseases including diabetes are nonadherent to their medications (Cramer, 2004; Krousel-Wood, Muntner, Islam, Morisky, & Webber, 2009). In this study, correlational cross-sectional study design was used to explore the factors that are linked to adherence to diabetes medications among diabetes patients in Cambridge. The factors that were investigated included age, gender, level of education, and diabetes knowledge. The quantitative method was appropriate for this study because data collection occurred by survey method

and the study questions were closed-ended (Creswell, 2009). The objectives of this study did not include observing or interviewing patients in their natural environment (Creswell, 2009). Thus, the qualitative method was not considered for this study. Moreover, cross-sectional design was most suitable for this study because the intention of this research was to ascertain the empirical relationship between the independent and dependent variables. Nonetheless, the goal of this research was not to determine causation (Campbell & Stanley, 1963). The predictive or independent variables were age, gender, level of education and diabetes knowledge, and the outcome or dependent variable was adherence to type 2 diabetes medications. A number of bivariate analyses were conducted for the independent variables in order to determine the link between the independent variables and adherence to medication (dependent variable). Additionally, multivariate analyses were conducted for each of the combination of variables to establish whether the group of two variables formed a more significant predictor than one variable alone.

Setting

This research was conducted at pharmacy located in the downtown area of Galt, Ontario. This pharmacy was chosen because it has clients with diabetes from all of the communities in the Cambridge area. The focal point of this research was communities in Cambridge, which has population of about 200,000 people of various backgrounds and ethnicities. Pharmacies in Cambridge are actively involved in helping diabetes patients to comply with their diabetes medication regimens through diabetes prescription refill reminder programs and diabetes educational clinics. A good number of adults in

Cambridge find it difficult to pay for their diabetes medications and also fail to keep doctor's appointments. As a pharmacist in Cambridge, I have noticed over the years that many individuals with diabetes fail to refill their medications when they are due. As a result, many diabetes patients end up with diabetes complications, mainly due to nonadherence to their diabetes treatment regimens. Patients 'ability to purchase needed diabetes medications plays a vital role in adherence to diabetes therapies(Nagelkerk et al., 2006). Studies have shown a significantly strong inverse relationship between out-of-pocket payment for type 2 diabetes medications and adherence to diabetes medication regimen (Karter, Ferrara, et al., 2000). A Canadian study also reported that lower income earners (*OR* 3.29, 95% CI 2.03–5.33), individuals without drug insurance (*OR* 4.52, 95% CI 3.29–6.20) were more likely to report that cost was the reason for their nonadherence (Law et al., 2012).

Population

The study participants for this research were individuals who filled their prescription at Metro Pharmacy, Cambridge. These individuals had a history of diabetes and were living in the Galt, Preston, and Hespeler communities of Cambridge. Participants were men and women 18 years of age and older who had been receiving treatment for their diabetes for at least one year. Researchers have shown that diabetes is on the rise in most parts of Canada, including in the province of Ontario, where Cambridge is located (Canadian Diabetes Association, 2009, 2011; Crossman et al., 2008; Public Health Agency of Canada, 2011). Identifying factors that influence

adherence to diabetes management plans may benefit patients, private drug insurance providers, stakeholders in government, and health practitioners who are involved in diabetes care in Cambridge communities. Participants in this study willingly took part in it, without being subjected to any form of pressure.

Sampling and Sampling Procedures

This research used convenience sampling. The individuals who were engaged as study participants filled their prescriptions at Metro Pharmacy Limited in Cambridge. Diabetes patients were informed of the research during prescription counseling sessions and when they came to the pharmacy to pick up their medications. Those recruited were given the consent form to complete. Fifty-nine individuals were recruited for the study, of whom 56 filled out the questionnaires completely.

Sample Size Calculation

This investigation involved four independent (age, gender, level of education, and diabetes knowledge) and one dichotomous dependent variable (adherence to type 2 diabetes medication). Logistic regression was used for statistical analysis. Statistical power analysis for logistic regression was carried out by following the guidelines, established in G*Power 3.1.7 (Faul, Erdfelder, Buchner, & Lang, 2013) and Lipsey and Wilson (2001) to calculate a sufficient sample size by using an alpha of 0.05, power of 0.80, and a medium effect size (odd ratio = 1.72) with a two-tailed test. Given the values obtained, the required sample size to accomplish empirical validity for logistic regression analysis with four predictors is a minimum of 117 patients as computed using the

G*Power 3.1.7 calculator . Consequently, this study required a minimum of 117 participants. However, the final sample size consisted of 56 participants, because it was difficult to find more patients to volunteer for the study.

It is possible that a larger number of participants may have produced outcomes different from the ones reported in this study. A larger sample might have covered a broader geographical area and a more diversified population than the one used in this research. Future researchers in this area may consider using a larger sample size in order to obtain results that are more representative.

Procedures for Recruitment, Participation, and Data Collection and Analysis

Metro Pharmacy Limited, Cambridge, was used as a recruitment and test administration center. Recruitment materials were offered to patients at the prescription pickup area of the pharmacy. Volunteers were recruited by informing them about the research during clinical interaction and medication counseling sessions. During the recruitment drive, exclusion and inclusion criteria were emphasized, and volunteers that met the inclusion criteria were given the informed consent form. Participants that handed in completed informed consent forms were advised of the time and location for the test, and each study volunteer was given a personalized identification number. The demographic survey instrument used for this research was adapted from the WHO STEPS instrument. This instrument is in the public domain (World Health Organization, 2017). Answering the survey questions took between one and two hours. Once a participant had completely filled out the survey materials, a thorough check of the test

material was conducted to ensure that no required data were missing. Results were made available to study participants who indicated their intention to receive the results. Results were given out in the same way that the survey had been administered.

The demographic questionnaire was used to collect the following information: name, date of birth, gender, education, names of other chronic diseases, household income, and marital and employment status. Age was divided into four categories: 35 to 44 years = 0; 45 to 54 years = 2; 55 to 64 years = 3; and 65 years and over = 3. Gender was categorized as male or female. Marital status was defined as married/common-law partner, single, divorced/widowed. Employment status was defined as employed or unemployed. Income was divided into five categories by annual income: below $200,000 = 1; $200,00 to $349,999 = 2, $350,00 to $559,999 = 3; $600,00 to $999,999 = 4; and $1000,000 and above = 5. Religion was categorized as Christianity, Islam, and others. Diabetes education referred to whether the participant had attended diabetes training classes. Other health-related information that was collected included: medication coverage status (social service funding, private insurance, self-funded); duration of diabetes and medication regimen status (number of diabetes medications, number of other medications used for other conditions). Level of education was categorized as elementary school, high school, college, or university education.

In addition to the demographic survey questionnaire, the eight-item Morisky Medication Adherence Scale (MMAS) and the Michigan Diabetes Knowledge Test were used for data collection. Adherence to diabetes medication was tested with the aid of

MMAS, which included questionnaires about adherence to medical therapies. This scale was developed from an original highly validated and reliable 4-item scale (Morisky, Ang, Krousel-Wood, & Ward, 2008). The 8-item scale is better at capturing barriers to adherence behaviors. Various investigators have also shown that the 4-item scale has a lower reliability compared to the 8-item scale ([α = .83, vs. α = .61]) (Krousel-Wood et al., 2009; Morisky, Ang, et al., 2008). The 8-item scale is allocated a 5-point Likert response scale on a range of 0 to 4. The remaining items use a 2-point Likert scale with a range of 0 to 1. For Items 1 to 7 on the MMAS, response options are *yes* or *no*. A score of 1 is assigned to every *no* response and every *yes* response is assigned a 0 score. Item 5 is an exception to this pattern, in that every *no* answer is assigned a score of 0 and every *yes* answer is assigned a score of 1. The highest possible score on the MMAS is 8, and the lowest possible score is 0. A score of 8 indicates high adherence, a score of 7 or 6 indicates a medium level of adherence, and a score of less than 6 is a reflection of poor or low adherence (Morisky, Ang, et al., 2008).

Ethical Protection of Participants

The rights and privacy of participants were fully protected in this study. Before the start of data collection, an informed consent form was given to each participant. Participants were fully informed of their right to not be part of the study before the commencement of the research, during the period of the investigation, and after the study had concluded. Concerns about patient confidentiality were completely addressed. The data obtained from each participant were protected by using a unique code to identify

each participant. Transcripts, files, and all other documentation related to the participants were stored in a securely locked cabinet in my office. Prior to data verification, all information that might identify a participant was removed from the transcript. The only individual who had access to patient data was myself . Before the start of data collection, I applied for and obtained approval for my research methodology from the Walden University Institutional Review Board (IRB). The approval number was 2016.11.2816;4033-06 00

Validity

Sample selection bias may have arisen in this study as a result of the convenience sampling technique that was used. This potential internal validity issue was addressed by recruiting diverse participants the various communities in Cambridge. Threats to external validity may arise when there is incorrect generalization from study participants to other individuals or the general population (Creswell, 2009). This external validity threat was addressed by not generalizing the results of this study to other populations that are dissimilar to diabetes patients in Cambridge. Construct validity threat of measurement is related to the association between a study's theoretical framework and instruments used for measurement (Frankfort-Nachmias & Nachmias, 2008). The measuring instruments used in this study aligned closely with the selected theoretical framework.

Instrumentation and Materials

The objective of this research was to establish whether there are factors associated with adherence to oral diabetes medications among type 2 diabetes patients in Cambridge

by means of a quantitative design method. This study explored the relationship between the independent variables (age, gender, income, level of education, and diabetes knowledge) and the dependent variable (adherence to diabetes medications) among individuals with type 2 diabetes in Cambridge. The instruments used in this study included a WHO demographic questionnaire, the MMAS, and the Michigan Diabetes Knowledge Test.

Demographic Questionnaire

Demographic data were obtained with the aid of the WHO STEPS demographic instrument (World Health Organization, 2017; see Appendix A) The demographic questionnaire contained questions that related to study participants' age, gender, education, ethnic group, income, family size and employment status. The question about age required participants to indicate their exact age. In response to the question about age ("What is your date of birth?"), respondents were expected to state their actual birthdate. The question about gender required study participants to indicate whether they were male or female. In response to the question about marital status ("What is your marital status?"), respondents were required to choose the most appropriate answer that applied to them from a list that included *married*, *not married*, *separated*, *divorced*, or *cohabiting*. The question about level of education was "What is the highest level of education you have completed?" Participants were required to chose an option from the following list: *no formal schooling*, *less than elementary school*, *elementary school*, *high school*, *college/university*, or *postgraduate degree*. In response to the question about

income or socioeconomic status ("Taking the past year, can you tell me what the average earnings of your household have been?"), respondents could choose to indicate this value per week, per month, or per year.

Morisky Medication Adherence Scale

The dependent variable for this study, adherence to oral diabetes medications, was assessed with the aid of the MMAS (Sweileh et al., 2014). The MMAS developed by Morisky, Green, and Levine (1986) is the best known and most commonly used questionnaire for assessing medication adherence (Čulig & Leppée, 2014). The MMAS is made up of eight questions designed to determine patient's medication adherence status (Appendix B):

1. Do you sometimes forget to take your pills? People sometimes miss their medications for reasons other than forgetting?
2. Thinking over the past two weeks, were there any days when you did not take your medicine?
3. Have you ever cut back or stopped taking your medication without telling your doctor because you felt worse when you took it?
4. When you travel or leave home, do you sometimes forget to bring along your medication?
5. Did you take your medicine yesterday?
6. When you feel like your diabetes is under control, do you sometimes stop taking your medicine?

7. And taking medication everyday is a real inconvenience for some people; do you ever feel hassled about sticking to your treatment plan?
8. How often do you have difficulty remembering to take all your medications? (Čulig & Leppée, 2014).

The first seven questions require a *yes* or *no* answer and the last question on the adherence scale is answered on a 5-point Likert scale. A point is assigned for each sentence based on the participant's answer. For the first seven questions, one point is awarded for each *no* answer while zero is given for each *yes* answer. The exception is Question 5, where 1 point is awarded for the *yes* answer and zero is given for a *no* answer. For Question 8, a score of 1 is assigned for *never/rarely* answer and 0 points is assigned for *all the time* (Sweileh et al., 2014). The total of the MMAS score is the sum of the scores for the eight questions. The overall score that is obtained ranges from 0–8. In this study, participants with an overall MMAS score of less than 6 were considered nonadherent, whereas participants with total score greater than or equal to6 were regarded as adherent (Čulig & Leppée, 2014; Sweileh et al., 2014).

The Michigan Diabetes Knowledge Test

This diabetes knowledge test (DKT) was used to assess study participants' diabetes knowledge (Appendix D). This validated instrument is the most commonly used diabetes knowledge test (Fitzgerald et al., 1998; Quandt et al., 2014). It was developed by the Michigan Diabetes Research and Training Center (MTRC) in the mid-1980s. Over time, this scale has been updated, resulting in a 23-item knowledge scale single test. The

23 questions on this test assess patient knowledge about diabetes. The test consists of two sections: a 14-item general knowledge diabetes test subscale, and a nine-item insulin-use knowledge test subscale. The 14-item general knowledge test subscale is used to test diabetes knowledge of individuals who do not manage their diabetes with insulin. However, the full 23-item test can be administered to individuals who use insulin. Both the nine-item insulin use subscale and the 14-item general subscale take about 15 minutes to complete. Flesch-Kincaid readability tests place the test's readability at a sixth grade reading level (Fitzgerald et al., 1998). Fitzgerald et al. (1998) conducted a study to determine the validity and reliability of the test by administering it to two different population groups. At the time of the study, the first group was receiving diabetes care from within the community through several different health providers, and the other group received all diabetes care from a local health department.

The authors used Cronbach's coefficient measure scale reliability for each population sample. The coefficient for the insulin-use as well as the general test shows that both subscales are reliable ($\alpha \geq 0.70$). Cronbach alpha measures the reliability of a scale (Cohen & Swerdlick, 1999) A Cronbach alpha score of ≥ 0.70 indicates high reliability (Fitzgerald et al., 1998). In spite of the fact that the samples were different demographically, the validity and reliability of the DKT were reinforced in both the health department and community samples. This shows that the DKT is reliable in different settings and also appropriate in a variety of patient populations. In this study a 14-item subscale was used for the DKT. Each correct answer was assigned one point with

the maximum score obtainable being 14. The total score of ≥ 7 was rated as good diabetes knowledge while a total less than 7 was rated as poor diabetes knowledge. Higher scores indicate higher knowledge of diabetes (Jasper et al., 2014). The DKT and its answer key are freely available online and can be downloaded (Michigan Diabetes Research Center, 2017).

This study's research hypotheses and research questions are listed below for review.

RQ1: Are the variables age, gender, diabetes knowledge, and level of education associated with adherence to diabetes medication among individuals with type 2 diabetes in Cambridge?

Ho1: There is no relationship between age and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

*H*a1: There is a relationship between age and adherence diabetes medications among individuals with type 2 diabetes in Cambridge.

Ho2: There is no relationship between gender and adherence to diabetes medications among individuals type 2 with diabetes in Cambridge.

*H*a2: There is a relationship between gender and adherence to medications among individuals with type 2 diabetes in Cambridge.

H03: There is no relationship between diabetes knowledge and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

*H*a3: There is a relationship between diabetes knowledge and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

H04: There is no relationship between level of education and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

*H*a4: There is a relationship between level of education and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

RQ2**:** Are any pair-wise combinations of the variables age, gender, diabetes knowledge, and level of education associated with adherence to diabetes medication among individuals with type 2 diabetes in Cambridge?

*H*o5: The age and gender combination is not significantly linked to adherence to diabetes medications among people with type 2 diabetes in Cambridge.

*H*a5: The age and gender combination is significantly linked to adherence to type 2 diabetes medication among individuals with diabetes in Cambridge.

*H*o6: The age and level of education combination is not a significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*a6: The age and level of education combination is significantly linked to adherence diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*o7: The age and diabetes knowledge combination is not significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*a7: The age and diabetes knowledge combination is significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*o8: The gender and level of education combination is not significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge

*H*a8: The gender and level of education combination is significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge

*H*o9: The gender and diabetes knowledge combination is not significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*a9: The gender and diabetes knowledge combination is not significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge

*H*o10: The level of education and diabetes knowledge combination is not significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge

*H*a10: The level of education and diabetes knowledge combination is significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

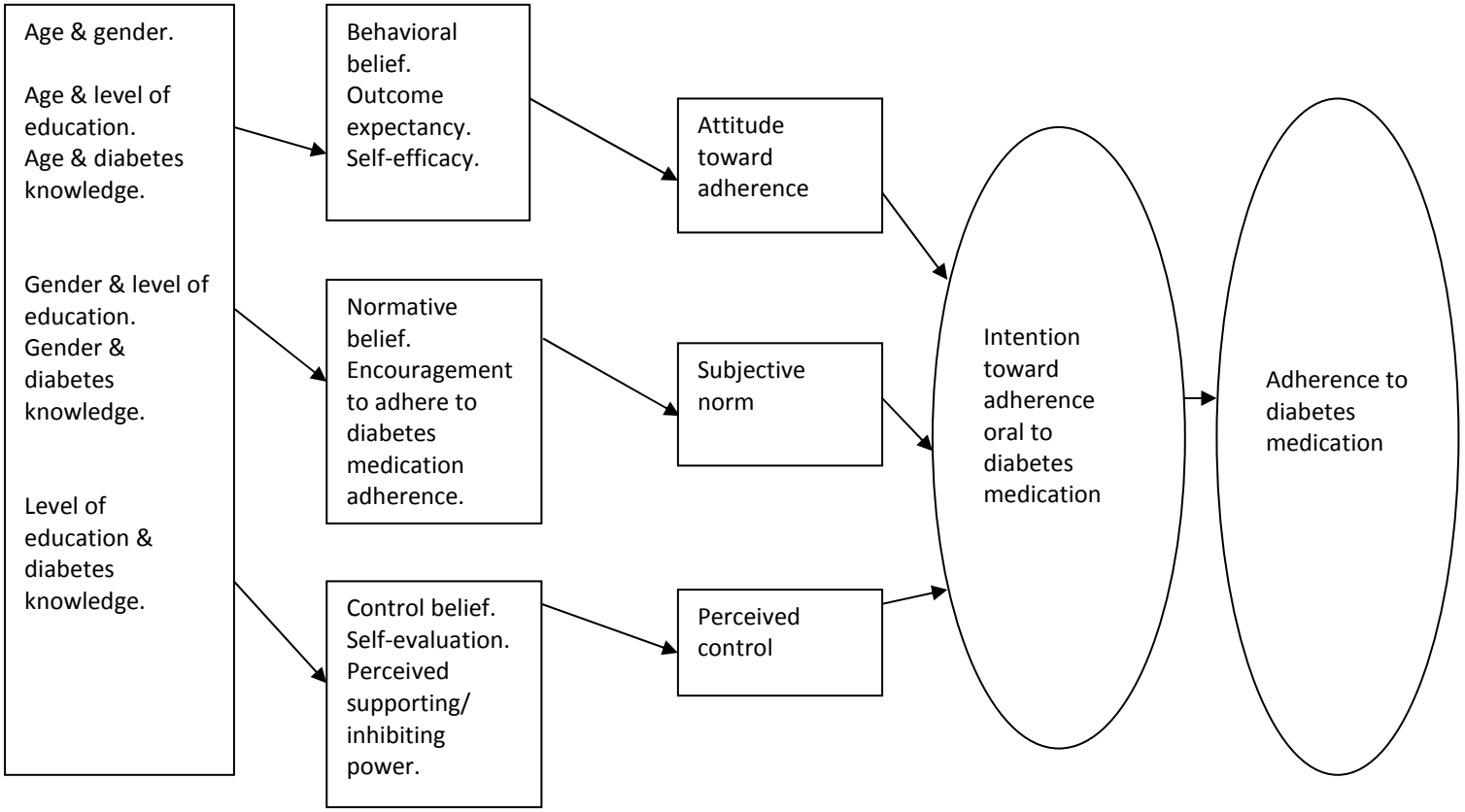

Figure 3. Fully diluted model with pair-wise fittings. Adapted and modified from "The Theory of Planned Behavior," by I. Ajzen, 1991, *Organizational Behavior and Human Decision Processes, 50*, p. 182. Copyright 1991 by I. Ajzen. Adapted from public domain with author permission

Analysis Plan

All the instruments used in this research (WHO SURE STEPS demographic instrument, DK test and MMS) were hand scored and data were collected and entered into SPSS version 21 for windows. Descriptive statistics (frequencies, proportion and means) were conducted to describe participant's demographic characteristics and other research variables (Gelaw et al., 2014; Khan et al., 2012). Logistic regression analysis was employed to test the two hypotheses of this study. Bivariate logistic regression analysis was used to test the first hypothesis. The strength of association between each of the independent variable (age, gender, level of education, income and diabetes knowledge) and the dependent variable (adherence to type 2 diabetes medication) was explored with the aid of bivariate logistic analysis (Park et al., 2010). In this analysis odds ratio was calculated based on a 95% confidence interval and an alpha level of 0.05 will be used (Park et al., 2010). Accepting or rejecting the Null hypothesis depend on the *P*-value. If the *P*-value obtained from the bivariate analysis test of associated between an independent variable and medication adherence *is* less than 0.05, the null hypothesis was rejected (Park et al., 2010). This indicated that the independent variable is a strong predictor of adherence to diabetes medications among individuals living with diabetes in Cambridge. Moreover, if the result shows an alpha value that is greater than 0.05, the Null hypotheses was accepted, indicating that the variable is not a strong predictor of adherence to diabetes medication in Cambridge. The second hypothesis was tested with the aid of multivariate regression logistic analysis to determine the effects of the

combination of two independent variables on medication adherence (Park et al., 2010). In the multivariate analysis, odds ratio was calculated based on a 95% confidence interval and the alpha level that will be 0.05. Accepting or rejecting the Null hypothesis depended on the *P*-value. If the *P*-value obtained from the test of the multivariate analysis of the effect of a combination of two variables on adherence was less than 0.05, the null hypothesis was rejected (Park et al., 2010). This showed that the combination is a strong predictor to adherence to diabetes medications among individuals living with diabetes in Cambridge. Moreover, if the result shows an alpha value that is greater than 0.05, the Null hypotheses was accepted, indicating that the combination is not a strong predictor of adherence to diabetes medication in Cambridge.

Logistic regression analysis method is appropriate for statistical analysis when the dependent variable is dichotomous with two likely outcomes and the independent variables are of any types (Agresti, 1996). The dependent variable in this study is adherence to diabetes medication and is determined by whether or not a diabetes patient is adherent (MMAS adherence score ≥ 6) or nonadherent (MMAS adherence score < 6) to prescribed diabetes medications according to the Morisky scale. The independent variables that were tested include: age, gender, level of education and diabetes knowledge. Logistic regressions surmount several of the stringent assumptions of linear regressions. In logistic regression, normally distributed variables, equality of variances, linearity between dependent and independent variables are not assumed, and also it does not assume that the error term variance is normally distributed. In general logistic

regression does not have stringent requirements. However, in logistic regression, outliers must not be present in data, outcome variable must be dichotomous and there must be a linear association between the odd ratio and the independent or predictor variables (Agresti, 1996; Tabachnick & Fidell, 2001). If outliers are discovered, they will be analyzed to ascertain if it due to patient's error or due to unusual circumstances. Linearity with an interval independent or ordinal variable and the odds ratio can be verified by creating a new variable that separates the existing independent or predictor variable into groups of equivalent intervals and running similar regression on these newly created categorical variable or categorized versions. Linearity is established if the B coefficient decreases or increases in a linear manner (Garson, 2009). Also larger sizes of samples are assumed in logistic regression because maximum likelihood coefficients are large study sample estimates. Logistic regression constructs a best fitting function or equation (model) by employing the maximum likelihood method, which maximally utilizes the probability of grouping the observed data into the proper class with respect to the regression coefficients (Agresti, 1996).

Inferential Statistics

The overall significance of the logistic regression was determined by examining the classification table, the display of the incorrect and correct classifications of the outcome variable. In addition, chi- square goodness of fit test was used to test the appropriateness of model. Wald statistic was used to determine the significance of each of the independent variables. Also EXP (B) value shows the raise in odds from one unit

raise in the selected variable (Agresti, 1996). Logistic regression assigns each independent a coefficient 'b' which measures the predictor variable impact on variations in the outcome variable. The Snell R^2, Cox and Nagelkerke R^2 used to determine the percentage of variance in the dependent variables that is predicted by the predictor variable (Field, 2009). Odd ratio value was used to ascertain the probability of the occurrence of an event and it is estimated by using the regression coefficient of the independent variable as the exponent or *exp* (Tabachnick & Fidell, 2001).The table of the Omnibus test result also contains a list of the predictor variables and the sig column which has the *p*-value for each predictor variable. Preselected alpha value for this research is 0.05. Predictors with *p*-values less than alpha (0.05) were regarded as statistically significant.

Multicollinearity

Multicollinearity is a situation in which two or more independent variables in a multiple regression model are very highly co-associated or correlated, indicating that one variable can be linearly predicted from the other variables present in the model with a considerable degree of accuracy (O'Brien, 2007). Multicollinearity can result in the following; inflate estimates of coefficient variance; produce models in which none of the variable have statistical significance; produce coefficient estimates of the "wrong sign" and of incredible magnitude; Produce situations in which slight changes in the data results in wide changes in coefficients estimates; and, in some extreme situations, multicollinearity can hinder the statistical solution of a model (Belsley, Kuh, & Welsch,

1980). Problems associated with multicollinearity can be crippling and could result in wrong inferences. One way of identifying multicollinearity is looking at the variance inflation factor (VIF). This factor determines how much the variance of an approximated regression coefficient increases if the independent variables are correlated. If no independent variables are associated or correlated, the VIFs will all be 1. Multicollinearity can also be diagnosed by Tolerant factor. This factor can be calculated by first obtaining the proportion or percentage of predictor variance that overlaps with the other independent variable or predictors. This number is then subtracted from 1; Variable Tolerance is 1- R^2. For instance, if the other independent variables explain 50% of the variance in x, the tolerance of x (in a model with those predictors) will be 1 - .5 = .5. Most statistical programs like the SPSS reports the results of Tolerance and variance factor test. A low or small tolerance value shows that the variable that is being considered is almost a perfect linear combination of other predictor variables that are already in the equation and as a result it should not be added to the regression equation. Variables that are in linear association will have a small tolerance.

According to Menard (1995), a tolerance value of less than 0.20 is a cause for concern and a tolerance value less than 0.10 almost unquestionably indicates a serious collinearity or multicollinearity problem. A maximum VIF value that is greater than 10 usually indicates that multicollinearity may be overly influencing the smallest square estimates (Hair, Anderson, Tatham, & Black, 1995; O'Brien, 2007). In this study, SPSS was used to check for and identify multicollinearity in the data set by running the

tolerance and VIF test. VIF value greater than 10 and tolerance value less than 0.2 will be indicative of the presence of multicollinearity (O'Brien, 2007). Multicollinearity can be minimized by; removing one of the variable that is highly correlated in the model: increasing study sample size, this will generally reduce standard errors; Ensuring that flagrant errors has not been made, for example , inaccurate use or entry of dummy or computed variables; It might just be best to accept that multicollinearity is present in the model and be alert to its consequences; centering the variables, variable can be centered by calculating the mean of each predictor variable, and then replace each of the value with difference between it and the mean (Belsley et al., 1980).

Summary

Chapter 3 contained an in-depth discussion of study methodology and reason why quantitative method was selected. Cross-sectional study design was used to explore the association between age, gender, level of education, diabetes knowledge, and adherence to type 2 diabetes medications among diabetes patients in Cambridge. The location for this research was Metro Pharmacy, Cambridge. Individual that accepted to participate in this research were given a coded research package that contains study questionnaires. Study participants were asked to complete the MMAS, diabetes knowledge test, and the demographic questionnaires. Bivariate and multivariate logistic regression analyses were used for the analysis of the data that will be gathered from participants. In Chapter 4 detailed results of data analysis conducted in Chapter 3 are given.

Chapter 4: Results

The purpose of this quantitative investigation was to examine factors related to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge, Canada. The variables assessed for their association with adherence to diabetes medication in the current study included age, gender, level of education, and diabetes knowledge. These independent factors may predict an association to adherence to type 2 diabetes medication (the dependent variable) among individuals with type 2 diabetes in Cambridge. The research questions and hypotheses were as follows:

RQ1: Are age, gender, diabetes knowledge, and level of education associated with adherence to diabetes medication among individuals with type 2 diabetes in Cambridge?

Ho1: There is no relationship between age and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

*H*a1: There is a relationship between age and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

Ho2: There is no relationship between gender and adherence to diabetes medications among individuals type 2 with diabetes in Cambridge.

*H*a2: There is a relationship between gender and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

H03: There is no relationship between level of education and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

*H*a3: There is a relationship between level of education and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

H04: There is no relationship between diabetes knowledge and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

*H*a4: There is a relationship between diabetes knowledge and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge.

RQ2**:** Are any pair-wise combinations of the variables age, gender, diabetes knowledge, and level of education associated with adherence to diabetes medication among individuals with type 2 diabetes in Cambridge?

*H*o5: The age and gender combination is not significantly linked to adherence to diabetes medications among people with type 2 diabetes in Cambridge.

*H*a5: The age and gender combination is significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*o6: The age and level of education combination is not significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*a6: The age and level of education combination is significantly linked to adherence diabetes medication among individuals with type 2 diabetes in Cambridge

*H*o7: The age and diabetes knowledge combination is not significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*a7: The age and diabetes knowledge combination is significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*o8: The gender and level of education combination is not significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge

*H*a8: The gender and level of education combination is significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*o9: The gender and diabetes knowledge combination is not significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*a9: The gender and diabetes knowledge combination is not significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*o10: The level of education and diabetes knowledge combination is not significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

*H*a10: The level of education and diabetes knowledge combination is significantly linked to adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

Chapter 4 is divided into three subsections. The introduction contains a brief summary of research purpose, questions, and hypotheses. The result section contains reports of descriptive and inferential statistical analysis. The results are organized by the research questions and hypothesis. Figures and tables are also included in the result subsection.

Data Analysis

Descriptive statistical analysis was employed to describe participant demographics and study variables. Percentages and frequency were computed for age, gender, level of education and diabetes knowledge. Binary logistic regression analysis was conducted for each independent variable and the dependent variable to identify whether there was an association between the predictor variable and the response variable. Multiple logistic analyses were conducted to determine whether any

combination of predictors was associated with adherence to diabetes medication among Cambridge residents with type 2 diabetes.

Results

A total of 56 individuals met criteria for participation in the research, signed the consent form, and correctly completed the questionnaire. Of the study participants who successfully completed the questionnaires, two (3.6%) were aged 35–44 years, nine (16.1%) were aged 45–54 years, 16 (28.6%) were aged 55–64 years, and 28 (51.8%) were aged 65 years and over. Data on the gender of participants indicated that 36 (64.3%) were male and 20 (35.7%) were female. All participants indicated that they lived in Cambridge. The mean age of study participants was 50.97 years. Additionally, 23 (41.1%) of the participants reported that they had an elementary-level education, 15 (26.8%) reported that they had a high school education, 9 (16.1%) indicated that they had a college education, and 9 (16.1%) indicated that they had graduated from a university. Table 1 summarizes the sociodemographic characteristics of the study sample.

Table 1
Frequency Distribution of Sociodemographic Characteristics of Study Sample

Variable	*n*	%
Age (years)		
35–44	2	3.6
45–54	9	16.1
55–64	16	28.6
65 and over	29	51.8
Gender		
Male	36	64.3
Female	20	35.7
Level of education		
Elementary	23	41.1
High school	15	26.8
College	9	16.1
University	9	16.1
Marital status		
Single	4	7.1
Married/common-law partner	39	69.6
Divorced/widowed	13	23.2
Family size		
1	13	23.2
2–3	49	73.2
4 and up	2	3.6

Note: $N = 56$.

Data on participants' diabetes knowledge indicated that 49(87.5%) participants displayed adequate or satisfactory knowledge of diabetes while 7(12.5%) participants had inadequate or poor knowledge of diabetes. The Michigan Diabetes Knowledge Test instrument was used for diabetes knowledge evaluation. A total score ≥ 7 was rated as good diabetes knowledge, whereas a total score <7 was rated as poor knowledge. Table 2 summarizes the frequency distribution of participants' diabetes knowledge.

Table 2
Frequency Distribution of Participants Diabetes Knowledge

Variable	*n*	Diabetes knowledge	
		Poor knowledge *n* = 7	Good knowledge *n* = 49
Age			
35–44	2	0 (0%)	2 (4.1%)
45–54	9	2 (28.6%)	7 (14.3%)
55	16	1 (14.3%)	15 (30.6%)
65 and over	29	4 (57.1%)	25 (51.0%)
Gender			
Male	3	6 (85.7%)	30 (61.2%)
Female	20	1 (14.3%)	19 (38.8%)
Level of education			
Elementary	23	5 (71.4%)	18 (36.7%)
High school	15	1 (14.3%)	14 (28.6%)
College	9	1 (14.3%)	8 (16.3%)
University	9	0 (0%)	9 (18.4%)
Marital status			
Single	4	2 (28.6%)	2 (4.1%)
Married/common-law partner	39	4 (57.1%)	35 (71.4%)
Divorced/widowed	13	1 (14.3%)	2 (4.1%)
Family size			
1	13	1 (4.1%)	12 (24.5%)
2–3	49	6 (85.7%)	35 (71.4%)
4 and up	2	0 (0%)	2 (4.1%)

Note: $N = 56$.

The levels of adherence of there search participants were as follows. Of the 56 study participants, 15 (26.8 %) reported poor adherence (adherence total scores of < 6 on the MMAS), and 41 (73.2%) reported good adherence (total adherence scores of ≥ 6 on the MMAS). The nonadherence rate of about 27% indicates that nonadherence is a problem among diabetes patients in Cambridge. Table 3 summarizes the frequency distribution of study participants' level of adherence to diabetes medications.

Table 3
Frequency Distribution of Participants' Adherence Level

Variable	*n*	Medication adherence	
		Poor adherence *n* = 15	Good adherence *n* = 41
Age			
35–44	2	0 (0%)	2 (4.9%)
45–54	9	2 (13.3%)	7 (17.1%)
55	16	5 (33.3%)	11 (26.6%)
65 and over	29	8 (53.4%)	21 (51.2%)
Gender			
Male	36	10 (66.7%)	26 (63.4%)
Female	20	5 (33.3%)	15 (36.6%)
Level of education			
Elementary	23	12 (80.0%)	11 (26.8%)
High school	15	1 (6.7%)	14 (34.1%)
College	9	2 (13.3%)	7 (17.1%)
University	9	0 (0%)	9 (22.0%)
Marital status			
Single	4	1 (6.7%)	3 (7.3%)
Married/common-law partner	39	11 (73.3%)	28 (68.3%)
Divorced/widowed	13	3 (20.0%)	10 (24.4%)
Family size			
1	13	3 (20%)	12 (24.5%)
2–3	49	12 (80%)	28 (68.3%)
4 and up	2	0 (0%)	2 (4.9%)

Note: $N = 56$.

Table 4 shows the results of testing multicollinearity in the study data. The findings show that the variance inflation factor (VIF) value of each the independent variables was within the limit, which was above 1.00 (Field, 2009; Myers, 1990). The tolerance value of each predictor variable was noted to be more than 0.2, and as result, multicollinearity was ruled out as an issue in this study (Menard, 1995; O'Brien, 2007).

Table 4
Collinearity Matrix of Independent Variables

		Collinearity statistics	
Variable	Significance	Tolerance	VIF
Age	.769	.973	1.028
Gender	.944	.956	1.046
Level of education	.011	.923	1.083
Diabetes knowledge	.018	.917	1.091

Note: N = 56.

Hypothesis Testing

Research Question 1

Research Question 1 was as follows: Are the variables of age, gender, diabetes knowledge, and level of education associated with adherence to diabetes among individuals with type 2 diabetes in Cambridge?

The first hypothesis tested in this study was related to age and adherence to type 2 diabetes medications. The first hypothesis states that there is no relationship between age and adherence to type 2 diabetes medications among individuals with type 2 diabetes in Cambridge. To determine the correlation between age and adherence to type 2 diabetes medications, a binary logistic regression analysis was conducted. The dependent variable (adherence to diabetes medication) was measured on a categorical scale, and coded as 1 = poor adherence (total score on the MMAS <6) and 2 = good adherence(total score on the MMAS ≥6). Age (independent variable) was categorized into groups and assigned the value of 0, 1, 2, or 3 to represent age groups 35–44, 45–54, 55–64, and 65 and over, respectively. For the age group 35 to 44 years, all (100%) participants were good

adherents to type 2 diabetes medications (*n* = 2; 3.6%). Participants in the age group of 45 to 54 had an adherence rate of 77.8% and a nonadherence rate of 22.2% to type 2 diabetes medications (*n* = 9; 16.1%). Patients in the55 to 64 age group showed adherence of 68.8% and nonadherence of 31.2% to their diabetes medications (*n* = 16; 28.6%). In the age group of 65 years and over, 72.4% of patients adhered to their diabetes medications and 27.6% were nonadherent (*n* = 29; 51.8%). Table 5 shows the results of the binary logistic analysis of age and adherence to diabetes medication .The odds ratio for the association between age and adherence to type 2 diabetes medications among individuals living with diabetes in Cambridge was calculated to 0.801 with a *p*-value of 0.549. Because the *p*-value calculated is greater than 0.05, the null hypothesis is not rejected. Therefore, there is no association between age and adherence to medications among individuals with type 2 diabetes in Cambridge .

The second hypothesis tested in this study was related to gender and adherence to type 2 diabetes medications which states that there is no relationship between gender and adherence to diabetes medications among individuals with type 2 diabetes in Cambridge. To examine this hypothesis, a binary regression analysis was performed. In this statistical analysis, adherence to diabetes medications (dependent variable) was measured on a categorical scale and coded 1 =poor adherence (total score on the MMAS is less than 6) and 2 = good adherence (total score on the MMAS is 6 and above). Gender was coded as 0 = male and 1 = female. The adherence rate for females was 75% and nonadherence rate was 25% (*n* = 20; 35.71%) while the males showed an adherence rate of 72.2% and a

nonadherence rate of 27.8% (n = 36; 64.28%.). Table 5 shows the results of the binary logistic regression. The odds ratio in the relationship of gender and adherence to type 2 diabetes medications was calculated to 1.154 with a p-value of 0.821. The calculated p-value is greater than 0.05. Therefore, we fail reject the null hypothesis. Accepting the null hypothesis indicates that there is no association between gender and adherence to diabetes medication among individuals with type 2 diabetes in Cambridge.

The third hypothesis tested in this study was related to level of education and adherence to type 2 diabetes medications. The third hypothesis states there is no relationship between level of education and adherence to medications among individuals with type 2 diabetes in Cambridge. To determine a correlation between level of education and adherence to type 2 diabetes medication, a binary logistic regression analysis was done. The dependent variable (adherence to diabetes medications) was given the value of 1 = poor adherence (total score on the MMAS is less than 6); and 2 = good adherence (total score on the MMAS is less 6 and above). Level of education (independent variable) was also given the value of 1, 2, 3, 4 to represent elementary school, high school, college and university respectively. Table 5 describes the results of the correlation analysis of level of education and adherence using binary logistic regression analysis. The result shows that the odds ratio of the association between level of education and adherence to type 2 diabetes medications was calculated to 3.473 with a p-value of 0.001. Since the p-value calculated is less than 0.05, the null hypothesis was rejected. Rejection of the null hypothesis suggest that there is significant statistical association between level of

education and adherence to diabetes medications among Cambridge residents with type 2 diabetes

The fourth hypothesis tested in this study was related to diabetes knowledge and adherence to type 2 diabetes medications. The fourth hypothesis states there is no relationship between diabetes knowledge and adherence to diabetes medications among individuals with diabetes in Cambridge. To determine a correlation between diabetes knowledge and adherence to diabetes medication, a binary logistic regression analysis was conducted. Adherence to diabetes medications (dependent variable) was measured on a categorical scale, and coded as 1 = poor adherence; 2= good adherence. Diabetes knowledge was also categorized into good and poor diabetes knowledge. Diabetes knowledge was coded as 0 = good diabetes knowledge (total score on the Michigan Diabetes Knowledge Scale is 7 and above; 1 = poor diabetes knowledge (Total score on the Michigan diabetes knowledge scale is less than 7). Table 5 describes the results of the binary logistic regression analysis of diabetes knowledge and adherence to diabetes medication. The odds ratio for the association between diabetes knowledge and adherence to type 2 diabetes medications among individual with diabetes in Cambridge was calculated to 0.103 with a *p*-value of 0.008. Although the *p*-value calculated is less than 0.05, since the odd ratio is less than 1, the null hypothesis was not rejected. There is therefore no association between diabetes knowledge and adherence to medications among Cambridge residents with type 2 diabetes.

Table 5
Binary Logistic Regression Omnibus Test Results of the Analysis of the Relationship Between Independent Variables and the Dependent Variable Using SPSS

Variable	*OR*	95% Confidence interval		*p*-value
		Lower	Upper	
Age & adherence	.801	.388	1.654	.549
Gender & adherence	1.154	.331	4.017	.821
Level of education & adherence	3.373	1.338	8.691	.001*
Diabetes knowledge & adherence	.103	.017	.609	.008*

Note: N = 56. Odds ratios were calculated using a 95% confidence interval. An alpha level of 0.05 was used.*Shows a strong association to adherence to medications among individual with type 2 diabetes in Cambridge.

Research Question 2

Research Question 2

Research Question 2 was as follows: Is there a group of factors that are linked to adherence to diabetes management among individuals with diabetes in Cambridge?

The fifth hypothesis tested related to age, gender and adherence to diabetes medication. The fifth hypothesis states that there is no associated between the combination of age, gender and adherence to diabetes medication among individuals with type 2 diabetes in Cambridge. The result of the multiple regression analysis of age, gender and adherence to type 2 diabetes medication is shown in Table 6. The analysis produced an odd ratio value of 0.805 for age, 1.124 for gender and a *p*-value of 0.816. Since the *P*-value is higher than 0.05, the null hypothesis was accepted. The combination

of age and gender is therefore, not a predictor of adherence to diabetes medications among individual with type 2 diabetes in Cambridge.

The sixth hypothesis tested related to age, level of education and adherence to diabetes medication. The sixth hypothesis states that there is no associated between the combination of age, level of education and adherence to diabetes medication among individuals with type 2 diabetes in Cambridge. Results in Table 6 shows that the combination of age and level of level education is a strong predictor of adherence to type 2 diabetes medications among individuals with type 2 diabetes in Cambridge. The analysis result shows that, the age odds ratio was calculated as 0.975 and odd ratio for level of education is 3.454 with a *p*-value of 0.003. Since the *P*-value is smaller than 0.05, the null hypothesis was rejected. Therefore, the combination of age and level of education was a predictor of adherence to diabetes type 2 medications among individuals with type 2 diabetes in Cambridge.

The seventh hypothesis states that there is no association between combination of age, diabetes knowledge and adherence to type 2 diabetes medications. As shown in Table 6, the odds ratio for the combination of age and diabetes knowledge was calculated as 0.770 for age and 0.100 for diabetes knowledge with a *p*-value 0.023. Since the *P*-value is smaller than 0.05, the null hypothesis was rejected. Therefore the combination of age and diabetes knowledge was a significant predictor of adherence to diabetes medications among Cambridge residents with type 2 diabetes.

The combination of gender and level of education is a strong predictor of adherence to diabetes medications among individuals living in Cambridge with type 2 diabetes. As reported in Table 6, the odds ratio calculated for gender is 1.224 and 3.465 for level of education with a *p*-value of 0.003. Since the *p*-value is smaller than 0.05, the null hypothesis was rejected. There is therefore a significant statistical relationship between the combination of gender, level of education and adherence to medications among individuals with diabetes type 2 diabetes in Cambridge.

The combination of gender and diabetes education is a strong predictor of adherence to type 2 diabetes medications among Cambridge residents with type 2 diabetes. As shown in Table 6, the odds ratio calculated for gender is .822 and 0.097 for diabetes knowledge with a *p*-value of 0.027. Since the calculated *p*-value is smaller than the significant *p*-value of 0.05, we reject the null hypothesis. Therefore, there is an association between the combination of gender, diabetes education, and adherence to type 2 diabetes medications among individuals residing in Cambridge with type 2 diabetes.

The combination of level of education and diabetes knowledge is a significant, strong predictor of adherence to diabetes medications among individuals living in Cambridge with type 2 diabetes. As reported in the Table 6, the odds ratio calculated for level of education is 3.198 and 0.140 for diabetes knowledge with a *p*-value of 0.000. Since the computed *p*-value for the combination is smaller than the significant *p*-value of 0.05, the null hypothesis was rejected, indicating that there is a statistical significant

relationship between the combination of level of education, diabetes knowledge and adherence to medications among individuals with diabetes type 2 diabetes in Cambridge.

Table 6
Multivariate Omnibus Test Results of the Analysis of Association of the Combination of Two Different Independent Variables and Adherence to Diabetes Medication

			95% Confidence interval		*p*-value
Variable	*OR*	*B*	Lower	Upper	
Age, gender, & adherence	.805 1.124	.212 .117	.389 .321	1.666 3.940	.816
Age, level of education & adherence	0.975 3.454	-.025 1.239	.437 1.360	2.176 8.771	.003*
Age, diabetes knowledge & adherence	.770 .100	-.261 -2.303	.349 .017	1.699 .603	.023*
Gender, level of education & adherence	1.224 3.465	.202 1.243	.312 1.338	4.809 8.649	.003*
Gender, diabetes knowledge & adherence	.822 .097	-.196 -2.329	.212 .018	3.185 .608	.027*
Diabetes knowledge, level of education, & adherence	.140 3.198	-1.967 1.163	.020 1.247	.980 8.200	.000

Note: $N = 57$. Odds ratios were calculated using a 95% confidence interval. An alpha level of 0.05 was used.*Shows a strong association to adherence to medications among individual with type 2 diabetes in Cambridge.

The result of the multiple regression analysis of the association of the combination of all the independent variables (age, gender, level of education and diabetes knowledge) and adherence to diabetes medication are summarized in Table 7.

Table 7
Multivariate Omnibus Test Results for the Association of the Combination of All the Independent Variables and Adherence to Diabetes Medication Using SPSS

			95% Confidence interval		*p*-value
Variable	*OR*	*B*	Lower	Upper	
Age	-.067	.935	.395	2.297	.880
Gender	-.093	.991	.209	3.97	.901
Level of education	1.147	3.148	1.210	8.192	.019*
Diabetes knowledge	-2.006	.135	.018	1.003	.050
Constant	1.509	5.521			.436

Note: $N = 56$. Odds ratios were calculated using a 95% confidence interval. An alpha level of 0.05 was used.*Shows a strong association to adherence to medications among individual with type 2 diabetes in Cambridge.

Summary

There was a statistically significant association between adherence to type 2 diabetes medications and level of education. In addition, the following combined variables; age and level of education; age and diabetes knowledge; gender and level of education; gender and diabetes knowledge; level of education and diabetes knowledge were noted to be significantly associated with adherence to type 2 diabetes medications. In Chapter 5 interpretations of the results, limitations of the research, recommendations and conclusion are presented.

Chapter 5: Discussion, Conclusions, and Recommendations

The purpose of this research was to investigate whether age, gender, level of education or diabetes knowledge predict adherence to type 2 diabetes medication among diabetes patients in Cambridge, Canada. The study is aimed at motivating and assisting Cambridge residence with type 2 diabetes to adhere to their diabetes medication regimens. The research sample consisted of 56 Cambridge residents who got their diabetes medication from Metro pharmacy in Cambridge. All study participants indicated that they had been diagnosed with type 2 diabetes and were taking diabetes medication regimens. Suboptimal adherence to the use of diabetes medication can result in high mortality and morbidity in individuals with type 2 diabetes (Nagelkerk et al., 2006). The prevalence and incidence of type 2 diabetes are on the rise in Canada (Canadian Diabetes Association, 2013; Public Health Agency of Canada, 2011) and the fact that no adherence study have ever been conducted among individuals with type 2 diabetes in Cambridge, it was necessary to focus on Cambridge residents with diabetes and address the research questions.

Patients' demographic data were collected using the WHO STEPS demographic instrument, diabetes knowledge was assessed with the Michigan Diabetes Knowledge Scale while medication adherence was measured with the MMAS. Binary and multiple logistic regression analyses were employed to analyze the data and test the hypotheses. The effects of all of the variables used in this study were explored using the overall model of omnibus test of coefficient or overall model significance. The omnibus test of

model coefficient table shows chi-square results that indicate whether there is a significant relationship between the dependent and the independent variables. Some of the findings were significant whereas others were not. The TPB was employed as the theoretical framework for this research

Interpretation of Findings

Finding 1: Age and Adherence

I discovered that there was no relationship between age and adherence to type 2 diabetes medications among Cambridge residents with diabetes. The adherence rate among participants in this study was 73.2%, compared to 26.8% nonadherence. For the age group 35 to 44 years, 100% of participants were good adherers to their type 2 diabetes medications (n = 2; 3.6%). Participants in the 45 to 54 group had an adherence rate of 77.8% and a nonadherence rate of 22.2% to type 2 diabetes medications (n = 9; 16.1%). Patients in the 55 to 64 group showed adherence of 68.8% and nonadherence of 31.2% (n = 16; 28.6%). In the 65 years of age and over group, 72.4% of patients adhered to their diabetes medications and 27.6% were nonadherent(n = 29; 51.8%). The statistical analysis results of the combined test model clearly showed that there is no statistically significant relationship between age and adherence to type2 diabetes medications among individuals with type 2 diabetes in Cambridge. The overall omnibus test of model coefficients yielded the following: chi-square = .373, p = .549, and OR = .801. The overall omnibus test of model coefficient odds ratio was .373, and the p-value was .549. There is therefore no association between age and adherence to type 2 diabetes

medications among individuals with type 2 diabetes in Cambridge. This finding is in concord with other studies that have reported that a patient's age is not a predictor of adherence to diabetes medications (Khan et al., 2012; Nozaki et al., 2009). However, the results of this study are in disagreement with other studies that have shown that age is a strong determinant of adherence to diabetes medications (Cramer, 2004; Garcia-Perez et al., 2013).

Finding 2: Gender and Adherence

There was no association between gender and adherence to type 2 diabetes medications among individuals with diabetes in Cambridge. The overall omnibus test of model coefficients for sex generated the following results: chi-square = 0.051, $p = 0.822$, $OR = 1.154$.The results of this study are in agreement with those of a study conducted in Uganda (Bagonza et al., 2015) and contrast with the findings of an adherence study conducted in Saudi Arabia (Khan, 2012). I also found that adherence was lower for male participants than for female participants. The adherence rate for females was 75%, compared to nonadherence of 25% ($n = 20$; 35.71%); males hadean adherence rate of 72.2% and a nonadherence rate of 27.8% ($n = 36$; 64.28 %).This result is in contrast to the result of an adherence study from the United Arab Emirates (Manjusha, 2014) that reported that men are better adherers than women. However, the findings in the present study are supported by previous studies conducted in Ethiopia and Germany (Gelaw et al., 2014; Raum et al., 2012). Regarding findings from this research, it may be worthwhile to conduct research into ways of encouraging male diabetes patients in

Cambridge to always seek medical attention when needed. Motivation can be increased through local campaigns and public announcements.

Finding 3: Level of Education and Adherence

I found that there was a significant relationship between level of education and adherence to type 2 diabetes medications among type 2 diabetes patients in Cambridge. The overall omnibus test of model coefficients for level of education yielded the following results: chi-square = 11.362; p = .008; *OR* 3= .473. The overall study adherence rate for study participants was 73.2%, and the medication nonadherence rate was 26.8%. Patients with only elementary education showed an adherence rate of 47.82% and a nonadherence rate of 42.18% (n = 23; 41.07%). Participants with high school education showed an adherence rate of 93.35% and a nonadherence rate of 6.65% (n = 15; 79%). The adherence rate for volunteers with a college education was 77.77%, compared to a nonadherence rate of 22.23 % (n = 9; 16.07%). Patients with university degrees showed a 100% adherence rate and a 0% nonadherence rate (n = 9; 16.07%). The result of this study contrasts with a study conducted in Uganda (Bagonza et al., 2015). However the findings in this study are in agreement with other studies that reported that level of education is significantly associated with adherence to type 2 diabetes medication (Gelaw et al., 2014; Khan et al., 2012). Based on the findings from this study, level of education may be investigated as a predictor variable in future adherence studies.

Finding 4: Diabetes Knowledge and Adherence

The results of the bivariate analysis of the association between diabetes knowledge and adherence to type2 diabetes medication among patients with type 2 diabetes shows that there is no significant relationship between diabetes knowledge and adherence to diabetes medications. The omnibus test of model coefficients for diabetes knowledge yielded the following overall results: chi-square = 7,120, p = .012, OR =0.103. Crosstab results show that 79.59% of study participants had good knowledge of diabetes, whereas 22.41% of the participants displayed poor diabetes knowledge. The results of this study are in disagreement with the results of the study conducted in Palestine by Sweileh et al. (2014), which indicated that diabetes knowledge is associated with adherence to diabetes medication. Based on the findings from this study, diabetes knowledge may be investigated as a predictor variable in future adherence studies. It may be more beneficial to tailor diabetes knowledge education classes to meet individual patient needs and circumstances. Some of the circumstances that need to be considered in designing diabetes education include participants' limited education, language barriers, and limited diabetes knowledge. Diabetes patients should always be encouraged to come to diabetes education classes with their family members. These relatives can assist them in better understanding the lessons that are taught to them in their diabetes education classes. Patient education is one of the most effective ways of managing diabetes and reducing complications (Mulcahy et al., 2011). WHO (2003) stated that health education

is beneficial to patients and that diabetes or health educators should stick to similar teaching protocols that will assist patient adhere to their diabetes management plan.

Finding 5: Age, Gender, and Adherence

The combination of age and gender was not noted to be a strong predictor of adherence to type 2 diabetes medications among diabetes patients in Cambridge using the alpha *p*-value of 0.05. The omnibus tests of model coefficients yielded the following overall results: chi-square =.407, $p = 0.816$, *OR* =.805/1.124. This finding clearly shows that the combination of sociodemographic factors such as age and gender is not associated with adherence. In this regard, this study is in agreement with another study conducted in Uganda (Bagonza et al., 2015). However, a study conducted in Saudi Arabia reported that age and gender were associated with adherence to diabetes medication (Salam & Siddiqui, 2013). Findings from this research may assist investigators in deciding the usefulness of age and gender in future adherence studies.

Finding 6: Age, Level of Education, and Adherence

The combination of age and level of education was noted to be a strong predictor of adherence to type 2 diabetes medications among diabetes patients in Cambridge. The results of the overall logistic regression omnibus tests of model coefficients were as follows: chi-square =11.366, $p = .003$, *OR* = 0.975/3.454. When age and diabetes knowledge were analyzed separately with the dependent variable, the result showed that age was not associated with adherence while diabetes knowledge was noted to be associated with adherence to type 2 diabetes medication. Surprisingly, when the

combination of age and gender was analyzed with adherence to diabetes medication in a multivariate analysis, the combination was noted to be a strong predictor of adherence to diabetes medication. Research on the association between adherence to type 2 diabetes medications and the combination of age and level of education has never been conducted in Cambridge. Therefore, the results of this research may be useful for future investigations involving the combinations of variables used in this study.

Finding 7: Age, Diabetes Knowledge, and Adherence

The combination of age and diabetes education was a good predictor of adherence to diabetes medications among type 2 diabetes patients in Cambridge. When age was analyzed with adherence to diabetes medication in a binary logistic regression analysis, age was noted to be a poor predictor of adherence. However, when the combination of age and diabetes knowledge was analyzed with adherence in a multiple logistic regression analysis, the combination was noted to be a strong predictor of adherence to diabetes medication. The overall result of the logistic regression omnibus test of model coefficients was as follows: chi-square = 7.559, p = .023, *OR* =770/.100. It is important to educate diabetes patients of all ages about diabetes and adherence to diabetes medication. Good diabetes knowledge is related to better adherence to diabetes medication.

Finding 8: Gender, Level of Education, and Adherence

The combination of gender and level of education was noted to be a strong predictor of adherence to type 2 diabetes medications among diabetes patients in Cambridge using the alpha p-value of 0.05. The omnibus tests of model coefficients

yielded the following overall results: chi-square = 11.447; p =0.003; OR = 1.224/3.465. When these two predictor variables (gender and level of education) were analyzed individually with the dependent variable, the result showed that gender was not a strong predictor of adherence while level of education was noted to be associated with adherence to type 2 diabetes. Interestingly, the combination of gender and level of education was noted to be a strong predictor of adherence to diabetes medication. Since the association of adherence to type 2 diabetes and the combination of gender and level of education have never been previously studied, future study is needed to explore whether gender combined with level of education is a predictor of medication adherence among type 2 diabetes patients in Cambridge.

Finding 9: Gender, Diabetes Knowledge and Adherence

There is an association between the combination of gender, diabetes knowledge and adherence. The combination of gender and diabetes knowledge was noted to be strong in predicting adherence to type 2 diabetes medications among diabetes patients in Cambridge using the alpha p-value of 0.05. The overall omnibus tests of model coefficients produced the following results: chi-square =7.201, p = 0.027, OR = .822/.097. When these two predictor variables (gender and diabetes knowledge) were analyzed individually with the dependent variable, the result showed that gender was not a strong predictor of adherence and that diabetes knowledge was not statistically associated with adherence to type 2 diabetes. Unpredictably, the combination of gender and diabetes knowledge was noted to be a strong predictor of adherence to diabetes

medication. Because the association of adherence to type 2 diabetes and the combination of age and gender have not been previously studied, future study is needed to explore whether gender combined with diabetes knowledge is a predictor of medication adherence among type 2 diabetes patients in Cambridge.

Finding 10: Level of Education, Diabetes Knowledge and Adherence

There is an association between the combination of level of education and diabetes knowledge and adherence. The combination of level of education and diabetes knowledge was noted to be a strong predictor of adherence to type 2 diabetes medications among diabetes patients in Cambridge using the alpha *p*-value of 0.05.The overall omnibus tests of model coefficients produced the following results: chi-square = 15.804, $p = 0.000$; $OR = 3.198/.140$. When these two predictor variables were analyzed individually with the dependent variable, the result showed that level of education was significantly associated with adherence while diabetes knowledge was not statistically associated with adherence among type 2 diabetes patients in Cambridge. It is therefore surprising that the combination of level of education and diabetes knowledge was a strong predictor of adherence to diabetes medication. Consequently, this result indicates that intervention that employs an integrative approach might be useful for addressing the adherence issue among individuals with diabetes in Cambridge. In that the association of adherence to type 2 diabetes medication and the combination of level of education and diabetes knowledge have not been previously studied in Cambridge, future study is needed to explore whether level of education combined with diabetes knowledge is a

predictor of medication adherence among type 2 diabetes patients in Cambridge. Moreover, in the fully adjusted model in which adherence was assessed as a function of each of the following—age, gender, level of education, and diabetes knowledge—only level of education showed a statistically significant relationship with adherence, as shown in Table 3. Further, the multiple logistic analysis of the combination of all of the variables with adherence also showed that only level of education significantly associated with adherence, as shown in Table 7. This suggests that intervention that focuses on helping diabetes patients, especially those with low levels of education, to fully understand the benefits of adherence to medication can help in improving adherence to diabetes medications.

Recommendations

The research results show that only level of education is strong predictors of adherence to type 2 diabetes medications among diabetes patients in Cambridge. Consequently, further research is required to identify other possible predictors. The development of diabetes knowledge through education is known to have a role in diabetes management, in that it builds required skills and empowers patients to take up everyday responsibilities to manage their disease condition (Khunti et al., 2008). It is the duty of clinicians to organize and teach personalized diabetes education classes. However, it is also the duty of patients to attend diabetes education classes. WHO (2003) stated that health education is for beneficial to patients and that health or diabetes educators should stick to similar teaching protocols that will assist adhere to their

diabetes management plan. Diabetes clinics, hospitals, and diabetes educators and physicians must stick to similar protocols for educating patients about diet, foot care, alcoholic beverage consumption, exercise, medication adherence, and the effects that these have on diabetes management and the onset of diabetes complications. Diabetes education can assist in increasing patients 'awareness about self-management and medication adherence. Furthermore, future researchers may consider the effects of variables such as income and family size on adherence to type 2 diabetes medications. Symptoms of diabetes generally become obvious to patients when their blood sugar levels are well above normal. Therefore, healthcare professionals should encourage patients to engage in regular glucose testing, so that patients can see the need to adhere to their medications, engage in prescribed exercise, and follow a recommended diet. In addition, because diabetes knowledge is a modifiable factor, physicians and other clinicians involved in diabetes care should be encouraged to always give clear, high-quality information about diabetes and diabetes medications. Diabetes information should always be communicated in a manner that will help patients become more aware of potential future complications of diabetes and the benefits of adhering to drug therapy. This research was a small cross-sectional study; future large-scale research is required for more understanding of the issue of adherence and development of more better effective interventions.

Limitations of the Study

This research study is limited to only patients diagnosed of type 2 diabetes and lived in Cambridge. Members of the population with type 2 diabetes that indicated their intention to be part of this study were very limited and as a result I used convenient sampling method because it affords me the opportunity to collect data from population members that were conveniently available. Also convenient sampling method enabled me to realize the sample size that I could achieve in a relatively fast and inexpensive way. As a result of the use of convenience sampling method for study participants recruitment, this research is limited to type 2 diabetes patients in Cambridge and should not be generalize beyond similar population with type 2 diabetes. The sample size used for this study was small and it is possible that a larger number of participants than the one used in this research may have produced outcomes different from the ones reported in this study. Larger sample size may cover a broader geographical area, and may have more diversified population than the one used in this research. This study was correlational in nature and as a result, the focus was on the association between factors (independent variables) that influence adherence to diabetes medications (dependent variable) and as a result causation was not assessed. Future investigators may contemplate using another population to explore and clarify factors that are associated with adherence to type 2 diabetes. Finally, study participants' adherence to diabetes medications were based on self-assessment reports that were not observed nor examined; thus, their actual adherence

to diabetes medication may be overestimated and may have some biases that could not be verified.

Implications for Social Change

Swan (2010) stated that assisting diabetes patients to understand their barriers to managing their diabetic condition is paramount to preventing the barriers. Knowing the reason why diabetes patients are not able to take their medication as prescribed is essential for the individual patient, their family and healthcare providers. Reducing cost and diabetes-related complications and improving the quality of life of patients is important to all stockholders: financiers of healthcare for those without insurance, insurance payers, the government, health professionals, patients, and their families. A good knowledge of diabetes and optimal adherences to prescribed medications by patients with type 2 diabetes in Cambridge will help decrease complications such as retinopathy, kidney disease, peripheral neuropathy, coronary and artery disease. Adherence to diabetes medications help improves well-being, preserves body image and prevents premature deaths. In addition, adherence to diabetes medications help improves patients' psychological well-being, encourages and empowers patient to self-manage their diabetes condition. The findings of this study research could aid in implementing national policies in relation to adherence to diabetes medication in Canada for individual with type 2 diabetes. Diabetes education through video or reading materials should be provided in physicians and pharmacy waiting rooms. Adequate Incentives such as coupons, free diabetic needles and strips should be offered to patients as a way of

encouraging them to attend diabetes education classes. Funds through grants from stakeholder should be made available for the promotion of diabetes education through the mass media on a regular basis.

Conclusion

In this study, assessment of the factors that influence adherence to type 2 diabetes medications was conducted in a cross-sectional setting. While a good number of individuals with type 2 diabetes in Cambridge engage in medication adherence behaviors, knowing and understanding factors that impact adherence to diabetes medication can help in the creation and utilization of the right intervention program that will create positive behavior change in patient. Analysis of the association between adherence to diabetes medication and each of the following; age, gender, level of education and diabetes knowledge shows that only level of education influences adherence to diabetes medication. The result of this study shows that type 2 diabetes patient with higher levels of education adhere better to their medication compare to those with lower levels of education. Intervention that focuses on helping diabetes patient especially those with low level of education to fully understand the benefit of adherence to medication can help in improving adherence to diabetes medication and prevention of diabetes-related complications. Good adherence promotes better quality of life which consequently benefits the patients, their family members, healthcare payers, health providers, and society.

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Appendix A: IRB Material Approval

IRB Materials Approved - Benedict Atekha

IRB < irb@waldenu.edu>

Mon 2016-11-28, 5:41 PM

Mon 2016-11-28, 5:41 PM

Dear Mr. Atekha,

This email is to notify you that the Institutional Review Board (IRB) has approved your application for the study entitled, "Factors Associated with Adherence to type 2 Diabetes Medications in Cambridge, Ontario, Canada."

Your approval # is 11-28-16-0281404. You will need to reference this number in your dissertation and in any future funding or publication submissions. Also attached to this email is the IRB-approved consent form. Please note, if this is already in an on-line format, you will need to update that consent document to include the IRB approval number and expiration date.

Your IRB approval expires on November 27, 2017. One month before this expiration date, you will be sent a Continuing Review Form, which must be submitted if you wish to collect data beyond the approval expiration date.

Your IRB approval is contingent upon your adherence to the exact procedures described in the final version of the IRB application document that has been submitted as of this date. This includes maintaining your current status with the university. Your IRB

approval is only valid while you are an actively enrolled student at Walden University. If you need to take a leave of absence or are otherwise unable to remain actively enrolled, your IRB approval is suspended. Absolutely NO participant recruitment or data collection may occur while a student is not actively enrolled.

If you need to make any changes to your research staff or procedures, you must obtain IRB approval by submitting the IRB Request for Change in Procedures Form. You will receive confirmation with a status update of the request within 1 week of submitting the change request form and are not permitted to implement changes prior to receiving approval. Please note that Walden University does not accept responsibility or liability for research activities conducted without the IRB's approval, and the University will not accept or grant credit for student work that fails to comply with the policies and procedures related to ethical standards in research.

When you submitted your IRB application, you made a commitment to communicate both discrete adverse events and general problems to the IRB within 1 week of their occurrence/realization. Failure to do so may result in invalidation of data, loss of academic credit, and/or loss of legal protections otherwise available to the researcher.

Both the Adverse Event Reporting form and Request for Change in Procedures form can be obtained at the IRB section of the Walden website: http://academicguides.waldenu.edu/researchcenter/orec

Researchers are expected to keep detailed records of their research activities (i.e., participant log sheets, completed consent forms, etc.) for the same period of time they retain the original data. If, in the future, you require copies of the originally submitted IRB materials, you may request them from Institutional Review Board.

Both students and faculty are invited to provide feedback on this IRB experience at the link below:

http://www.surveymonkey.com/s.aspx?sm=qHBJzkJMUx43pZegKlmdiQ_3d_3d

Sincerely,

Libby Munson

Research Ethics Support Specialist

Office of Research Ethics and Compliance

Email: irb@waldenu.edu

Fax: 626-605-0472

Phone: 612-312-1283

Office address for Walden University:

100 Washington Avenue South, Suite 900

Minneapolis, MN 55401

Information about the Walden University IRB, including instructions for application, may be found at this link:

http://academicguides.waldenu.edu/researchcenter/orec

Appendix B: National Institute of Health Certificate of Completion

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that

Benedict Atekha successfully completed the NIH Web-based training course

"Protecting Human Research Participants."

Date of completion: 06/24/2012

Certification Number: 942394

Appendix C: Written Permission to Use Michigan Diabetes Knowledge Test

On Aug 2, 2016, at 10:56 PM, Benedict Atekha < benedict.atekha@waldenu.edu> wrote:

James T. Fitzgerald, Ph.D.

Department of Medical Education

University of Michigan Medical School

Dear Dr. Fitzgerald,

My Name is Benedict Atekha. I live in Canada. I am a PhD student at Walden University. My program is Doctor of Public Health with a concentration in Epidemiology. I am currently in the dissertation stage of my program and my dissertation is titled; Factors Associated with Adherence to Diabetes Management in Cambridge, Canada. Diabetes knowledge is one of my independent variable. I am asking for your permission to use the Michigan diabetes test for my dissertation. I already retrieved this instrument from http://www.med.umich.edu/mdrtc/profs/survey.html#dkt.

I will appreciate any advice on how to use DKT. Any usage tips and useful updates will be appreciated

Thanks

Benedict Atekha

On Wed, Aug 3, 2016 at 8:47 AM, Fitzgerald, Tom < tfitz@med.umich.edu> wrote:

You have our permission to use the Diabetes Knowledge Test. I m sending you the revised test that was published this year and a T/F version developed by researchers in Ireland for low literacy individuals. Good luck with your dissertation.

James T. Fitzgerald, PhD

Professor

Department of Learning Health Sciences

217 Victor Vaughn Building

1111 E. Catherine Street

Ann Arbor, MI 48109-2054

ph:734-936-1644 fax:734-936-1641

Associate Director

Education and Evaluation

GRECC

Ann Arbor Medical Center (11G)

2215 Fuller Road

Ann Arbor, MI 48105-2300

ph:734-845-3047 fax:734-845-3298

tfitz@med.umich.edu

Appendix D: Request to Use Medication Adherence Questionnaire

Benedict Atekha < benedict.atekha@waldenu.edu>

Tue 2016-03-29, 11:42 AM

josip.culig@stampar.hr

Dear Professor Josip Čulig

My Name is Benedict Atekha. I am a pharmacist and I practice in Canada. Also I am a PhD student at Walden University. My program is Doctor of Public Health with a concentration in Epidemiology. I am currently on the dissertation stage of my program and my dissertation is titled; Factors Associated with Adherence to Diabetes Management in Cambridge, Canada. I am interested in using the Morisky medication adherence questionnaire to assess medication taking behavior among diabetes patients in Cambridge. As a result I will like to request you to please allow me to use the medication adherence questionnaire (Figure 1) in your journal titled *From Morisky to Hill-Bone; Self-Reports Scales for Measuring Adherence to Medication*. I tried to reach Professor Morisky, I was told that he is on medical leave. I will be glad if you could grant me the permission to use your questionnaire in my dissertation

Thanks

Benedict Atekha

Walden University

benedict.atekha@waldenu.edu

Document in Document1

Josip Čulig < josip.culig@stampar.hr>

Reply all |

Thu 2016-03-31 8:17 AM

To: Benedict Atekha < benedict.atekha@waldenu.edu Inbox

Dear Benedict,

you are welcomed to use my scale. According to our legal department you should accept the terms from document. If you need anything else do not hesitate to ask.

Best regards

Josip Čulig

Appedix E: Permission to use The planned Behaviour Theory

On Nov 26, 2017, at 05:54, Benedict Atekha <benedict.atekha@waldenu.edu> wrote:

Professor Icek Ajzen

Division of Social Psychology

University of Massachusetts

Dear Professor Ajzen,

Greetings! I hope this email does not come as a surprise. I am Benedict Atekha, a Ph.D. Candidate of Walden University. I am currently in dissertation writing. My study is about "Factors associated with Adherence to Type 2 Diabetes Medication in Cambridge, Ontario, Canada" using the theory of planned behavior (TPB) as the theoretical framework.

I understand that the use of planned behaviour theory is free and is available in the public domain, but I would like to ask for permission to use the theory in my research. This is also to comply with requirements from the IRB to ask permission to use the theory of planned behaviour and adaption of the drawing for my research.

Hope to hear from you soon. Have a great day!

Thank you very much.

Sincerely yours,

Benedict Atekha

From: Icek Aizen <aizen@psych.umass.edu>

Sent: December 1, 2017 12:23 PM

To: Benedict Atekha

Subject: Re: Permission

Dear Mr. Atekha,

The theory of planned behavior is in the public domain. No permission is needed to use the theory in research, to construct a TPB questionnaire, or to include an ORIGINAL drawing of the model in a thesis, dissertation, presentation, poster, article, or book. If you would like to reproduce a published drawing of the model, you need to get permission from the publisher who holds the copyright. You may use the drawings on my website ("https://people.umass.edu/aizen/tpb.diag.html" or "https://people.umass.edu/aizen/tpb.background.html") for non-commercial purposes, including publication in a journal article, so long as you retain the copyright notice.

Best regards,

Icek Ajzen

Professor Emeritus

University of Massachusetts - Amherst

https://people.umass.edu/aizen