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Medicine Adherence as a Determinant of Complication Development in Diabetes and Hypertension Patients on a Medical Aid Scheme in Zimbabwe

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Walden University
2022

Abstract

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Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Public Health

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Abstract

Pharmacotherapy is a significant component of chronic disease management; its efficacy depends on long term, correct, and consistent use; however, medicine adherence rates remain low. The cost of medicines is considered a significant barrier to adherence, especially in low-income settings. This quantitative cross-sectional study was conducted using data from Cimas Medical Aid Society collected between 2015 and 2019. The purpose of the study was to determine the extent of the association between medicine adherence, complication development, and cost of care among diabetic and hypertensive patients while controlling for age and gender on a population that does not experience cost barriers to medicine access. The sample consisted of 23,303 diabetic and hypertensive patients above the age of 16 who purchased chronic medicines through medical aid. The chi-square test bivariate analysis showed a significant association between medicine adherence and complication development in hypertension ($p < 0.001$) and no association in diabetic patients. Binary logistic regression indicated that nonadherent patients were more likely to develop hypertension complications ($OR = 1.428$, $p < 0.001$) in females and older age groups. In diabetes patients, it showed no significant association between adherence and complication development ($OR = 0.993$, $p = 0.841$). The claims ratio was higher in nonadherent diabetes ($OR = 8.301$, $p < 0.001$) and hypertensive ($OR = 2.516$, $p < 0.001$) patients. The implications for positive social change include the findings being used to improve interventions for lowering non-cost barriers to medicine adherence, to reduce complication development, and lower the cost of care for diabetes and hypertension patients.

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Dedication

I dedicate this work to my husband, Bongani, who supports me in all my endeavours; to my children, Mehluli, Methembe, and Bukiwe, who are always my "why" and to the memory of my mother who taught me the virtue of hard work and my father who has been my lifelong cheerleader.

Acknowledgments

I am deeply indebted to my chair, Dr. Pelagia Melea, for the support, assistance, and patience as I worked on this dissertation, and to my Committee Member, Dr Stacy-Ann Christian, whose insights provided further refinement. I would also like to express my deepest gratitude to Cimas Medical Aid Society for sponsoring this study and allowing me to use their data and to the Cimas team for all the support and encouragement throughout this study.

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Section 1: Foundation of the Study and Literature Review

Over the two centuries, life expectancy across the globe increased dramatically. Between 1950 and 2017, life expectancy increased from 48.1 years to 70.5 years for men and from 52.9 years to 75.6 years for women (Dicker et al., 2018). Whereas in the 1900s, the leading cause of death was infectious diseases, such as pneumonia, tuberculosis, and gastrointestinal infection, there has been a shift towards noncommunicable diseases (NCDs) as the leading cause of death (Dicker et al., 2018; Gouda et al., 2019). According to these authors, this epidemiological transition is attributable to globalization and urbanization with the attendant changes towards sedentary lifestyles and a diet with more refined sugars.

The World Health Organization (2018) reported that NCDs, such as diabetes and hypertension (HTN), have overtaken infectious diseases as the most common cause of mortality and morbidity. While HTN and diabetes are potentially preventable, medicinal treatment remains the most commonly used method to manage these lifelong conditions (Al-Azzam et al., 2021) . The correct and consistent use of medicine according to the prescribed regime is known as medicine adherence or compliance (Ibrahim et al., 2021). Physicians and pharmacists counsel patients on the importance of medicine adherence; however, worrisome nonadherence rates persist (Atinga et al., 2018; Omotosho & Peace, 2019; Vogler, 2018). The most common reason for nonadherence is the cost of medicines, followed by refill logistics and the discomfort of the associated side effects (Morgan & Lee, 2017). Medical aid members' schemes cover the cost of medicines mitigating against the cost barrier; however, adherence remains a challenge even among

these populations (Marcum et al., 2013; Vogler, 2018). Nonadherence results in poorly controlled conditions, increasing the chances of catastrophic health events, such as cardiovascular disease and stroke, that impact the patient's health status and increase their health spending.

In this study, I examined the medicine adherence of chronic HTN and diabetes patients covered by a medical aid scheme and the impact of nonfinancial factors that facilitate or mitigate against adherence. I examined the rate of development of complications among the adherent and nonadherent members to recommend interventions that may improve adherence and reduce complication development.

In this section of the study, I provide background information on HTN and diabetes globally, in the Sub-Saharan region of Africa, and focus on Zimbabwe specifically. I also present the problem statement and the research questions, discuss the theoretical framework of Andersen's behavioral model of health services use, and describe the limitations and delimitations of the study. With this research, I aimed to positively impact the community, so I conclude the section by discussing the implications of the study's findings on social change.

Background

NCDs are a growing public health problem and have become the most common cause of morbidity and mortality responsible for 71% of global annual deaths (Bigna & Noubiap, 2019; World Health Organization, n.d.-c) Women are disproportionately affected by NCDs, which account for 2 out of every 3 deaths in women globally (World Health Organization, n.d.-b). While HIV/AIDS continues to be the leading cause of death

in Zimbabwe, the U.S. Agency for International Development (2017) highlighted the increase of premature deaths due to NCDs, such as diabetes and HTN. The World Health Organization (2018) reported that in 2016, NCDs, led by HTN and diabetes, accounted for 33% of all deaths in Zimbabwe.

HTN is the most prevalent cardiovascular disease in Zimbabwe with a prevalence rate of 30% (World Health Organization, 2013) and an estimated mortality rate of 21% (Mutowo, Mangwiro, et al., 2015). Several studies have demonstrated that HTN prevalence is higher in men younger than 60 years old, after which it becomes higher in postmenopausal women globally (Gillis & Sullivan, 2016; Reckelhoff, 2018). No current survey-based data exists for Zimbabwe, and so I sought to provide some insight into the local prevalence rates, which are imperative for health care planning, with the current study. Globally, HTN is responsible for at least 45% of deaths due to heart disease and 51% of deaths due to stroke, and nearly 80% of the deaths occur in low- and medium-income countries (World Health Organization, 2013). The comparatively lower rates in Zimbabwe are attributable to the asymptomatic nature of HTN, resulting in late diagnosis, albeit after significant damage to internal organs, such as the heart and kidneys (Mutowo et al., 2015).

Diabetes is a global problem unequally distributed across different regions, with a low prevalence of 5.2% for Sub-Saharan Africa and 4.5% for Zimbabwe (World Health Organization, 2018). Scholars have posited that the low rates in the resource-constrained regions are due to undiagnosed cases rather than the absence of disease (Mutowo,

Gowda, et al., 2015). Undiagnosed diabetes is usually only recognized after complication development (Al-Azzam et al., 2021).

HTN and diabetes are interrelated and codependent conditions that display mutual exacerbation, resulting in the significant overlap in underlying risk factors and resultant adverse health events, such as atherosclerotic cardiovascular disease and renal failure (Thurnes, 2018). Up to 75% of adults with diabetes also have HTN, and patients with HTN alone often show evidence of insulin resistance (Roberts et al., 2014; Yiu et al., 2018).

HTN and diabetes burden global health care systems and the general economies. Direct costs emanate from expenditures on prevention, diagnosis, and treatment of the disease and its complications. Globally, the cost of diabetes is estimated at US $827 billion, comprising $174 billion for diabetes and $766 billion for HTN-related problems (Wang et al., 2017). Mutowo et al. (2016) and Patel (2016) posited that the cost of health care is one of the major determinants of access to quality health care. Mutowo et al. calculated that the cost of hospitalization due to diabetes and HTN in public hospitals in Zimbabwe is about $900 per person per episode, in a country with average health spending of $79 per capita (The Global Economy, 2015). The costs are exacerbated where in-hospital care is required due to complication development and catastrophic health events, like myocardial infarction and stroke.

Prevention of disease is the most cost-effective option at both the individual and system levels because it facilitates health and well-being, reducing the overall national NCD burden and health expenditure (Centers for Disease Control and Prevention, 2019).

However, once the disease has set in, there are different treatment protocols for control to prevent the development of complications, such as lifestyle modifications, especially diet and physical activity, as well as the use of medicines. Compliance to treatment, especially pharmacotherapy, is, therefore, a predictor of favorable treatment outcomes (Brown & Bussell, 2011).

Chen et al. (2019) linked poor medicine adherence to higher disease-specific and all-cause hospitalization. The authors also observed that adherence decreased with the length of time on medication. HTN and diabetes are chronic illnesses that require lifetime adherence to prevent complication development. The results are similar to those obtained by Chen et al. (2014) that showed that prestroke medication nonadherence rate in patients who were admitted for ischemic stroke was 75%, and adherence was associated with enhanced admission HTN control and reduced occurrence of ischemic stroke. Hurst et al. (2015) also confirmed that achieving glycosylated haemoglobin (HbA1c) and blood pressure treatment targets is associated with a lower risk of developing microvascular complication. Morgan and Lee (2017) showed that cost-related nonadherence ranged from less than 3% to 18% in developed countries, while a similar measure could not be determined for low-income countries but can be reasonably assumed to be much higher. Omotosho and Peace (2019) observed that more than half of the medicines prescribed to chronic disease patients are not taken as recommended and are wasted. Boylan (2017), reporting for the National Association of Chain Drug Stores, estimated the global cost of wasted medicines at $300 billion annually.

Although medical aid membership eliminates the cost barriers to medicine access, Belina et al. (2019) demonstrated that adherence to treatment protocols remains significant within the population on medical insurance, especially among chronic disease patients. Sarfo et al. (2018) posited that when designing effective interventions to promote treatment adherence, it is imperative to establish factors influencing patients' adherence behavior. In this study, I examined the medicine adherence behavior of a medically insured population and made recommendations to reduce progression to complication development. The resultant higher cost of specialist care is detrimental to patient health and economically strenuous on the health fund.

Problem Statement

Medication nonadherence is a potentially modifiable cause of inadequate control of cardiovascular morbidities, and it is attributed to the cost of medicines, refill logistics, and lack of motivation (Atinga et al., 2018; Ryan et al., 2014; Turcu-Stiolica et al., 2017). Although Kleinsinger (2018) argued that nonadherence is an intrinsic behavior change problem rather than solely the result of extrinsic factors, the cost of medicines is cited as a primary contributor to nonadherence (Patel, 2016; Roberts et al., 2014; Zolotarova et al., 2016). It is known that medical insurance improves access to health care. In Zimbabwe, less than 10% of the population is on medical aid (Ministry of Health and Child Care, 2018) because of the unaffordability of the contribution rates and high unemployment (Muchabaiwa et al., 2017). Patients on medical aid schemes have most health care costs, including medication purchases covered, reducing the effect of affordability as a cause of nonadherence. However, little is known about the medication

adherence behavior of diabetes and HTN patients who are on medical aid and have markedly reduced cost-related barriers. Most literature focuses on cost-related nonadherence, and there is a dearth of literature on the impact of nonfinancial factors. Diabetes and HTN patients who are on health insurance would have the cost of medication covered; therefore, their medication adherence behavior would be attributable to factors other than cost.

National health systems and medical insurance companies are experiencing ever-increasing costs from rising chronic conditions (Belina et al., 2019). There is, however, little information on the cost of chronic disease, specifically HTN and diabetes, in Zimbabwe. With this study, I attempted to fill the identified gaps in literature, because to my knowledge, it is the first to examine the association between medicine adherence, the development of complications, and the cost of health care for people on medical aid. This knowledge is important in planning community interventions that encourage adherence and reduce health care costs. As the world and Zimbabwe move towards universal health care coverage, it is important to understand and plan for non cost-related adverse health behavior that may negate the effectiveness of the increased access to care.

Purpose

The purpose of this study was to determine the association between treatment adherence, the development of complications, and the claim ratio in diabetes and HTN patients who had medical coverage in Zimbabwe. The population of the study was the members of Cimas who were on treatment for diabetes and HTN in the 5 years between 2015 and 2019. I chose this population because most of literature on medicine adherence

is from low-income populations who face cost barriers, while this less-studied population may experience other barriers than cost. In Zimbabwe, medical insurance is largely provided through employer contracts (Muchabaiwa et al., 2017), so the study population were in the middle- to high-income bracket. This population is largely urban dwelling due to the location of industry and commerce in the cities (Zimbabwe National Statistics Agency, 2016).

Additionally, I conducted this study explore the impact of medication adherence behavior on the claim ratio of the patients and determine the extent to which nonadherence contributed to the claim costs of the medical fund. Such information can enable medical funders to design relevant communication to their members on chronic disease treatment and collaborate with care providers to institute appropriate interventions that encourage adherence.

The independent variable in this study was medication adherence, which was determined using medication possession ratio (MPR). MPR was derived from the number of days a patient had their medication available as observed from medicine claims on the medical aid. While medication possession does not directly infer utilisation, MPR is widely accepted as a proxy for adherence in studies that use secondary data (Canfield et al., 2019), such as this one. The second independent variable was the patient's annual claims ratio, defined as the percentage of claims costs incurred in relation to the premiums earned. This measure showed the disease-specific and all-cause cost of diabetes and HTN patients relative to the total membership cost of care. Complication development was the dependent variable and was defined as the number of disease-

specific and all-cause hospitalizations and referrals for further management, such as dialysis.

Research Questions and Hypotheses

This study was guided by the following research questions and their associated hypotheses:

Research Question 1: What is the extent of the association between medication adherence and complication development in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years of age and have been on treatment for more than 1 year, controlled for gender and age?

$H_0$1: There is no statistically significant association between medication adherence and complication development in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years old of age and have been on medication for more than 1 year, controlled for gender and age?

$H_1$1: There is a statistically significant association between medication adherence and complication development in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years old and have been on medication for more than 1 year, controlled for gender and age?

Research Question 2: What is the extent of the association between medication adherence and claims ratio in diabetic and hypertensive members of Cimas

Medical Aid Society who are above 16 years old and have been on medication for more than 1 year, controlled for gender and age?

$H_0$2: There is no statistically significant association between medication adherence and claims ratio in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years old and have been on medication for more than 1 year, controlled for gender and age?

$H_1$2: There is a statistically significant association between medication adherence and claims ratio in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years old and have been on medication for more than 1 year, controlled for gender and age?

I measured adherence using MPR, which denoted the number of days a patient had access to medication as derived from medication claims. Complication development data were derived from the number of disease-specific and all-cause hospitalizations and claims for further management, such as dialysis and retinopathy. Claims ratio was defined as the costs incurred for all medical services in relation to the contributions made by the patient to the medical aid fund.

Theoretical Framework

In this study, I used Andersen's behavioral model of health care use as the theoretical framework to examine medicine compliance behavior. The model was developed to explain how and why people utilize health care services and focuses on the utilization of specific components of health services, such as medication adherence, as well as using outcomes as the endpoint of analysis (Li et al., 2016). The original model

that focused on the family as the unit of study has been adapted to study individuals to mitigate the inherent heterogeneity of family members (Andersen, 1995).

According to the model, health services utilization is a sequential and conditional function of three categories of factors: predisposing, enabling and need factors (Andersen & Glaser, 1969). In the model, it was posited that health services utilization is determined by predisposing factors, which are the individual's propensity to use health services. These are socio-cultural characteristics of the individual before the illness, which include social structure (i.e., education, occupation, social networks, and culture); health beliefs (i.e., attitudes, values, and knowledge of the health care system); and demographic characteristics, such as age and gender (Andersen & Glaser, 1969). Enabling factors are the logistical aspects of adherence, including personal/family characteristics, which are largely economic factors, such as income, health insurance status, and the extent and quality of social relationships; community characteristics, such as the availability of medication and health care professionals; and genetic and psychological factors (Bradley et al., 2002). Li et al. (2016) argued that enabling factors may lead to inequity of health care services along the socioeconomic gradient and should be considered in ensuring equitable utilization across economic groups. Need factors are the immediate cause of health service use, from functional and health problems that necessitate health services use (R. M. Andersen, 1995). Perceived need is the self-determined, general health and functional state of the individual, informed by their experience of symptoms of illness and pain, regardless of whether they judge their problems to be of sufficient importance

and magnitude to seek professional help (Andersen, 1995). Evaluated need is derived from the professional judgment of health status and the need for medical care.

There is an intricate interplay between the three categories of factors. While need factors result in greater health services utilization, especially curative and hospitalization, they are influenced by predisposing factors, such as health belief, as well as cultural and enabling factors, such as medical insurance cover and service accessibility (Kabir, 2021). Predisposing and enabling factors are more likely to predict preventative care utilization (Kabir, 2021). The model predicts that the more easily changeable (i.e., mutable) a factor is, the greater the probability of changing health-seeking behavior and asserts that demographic characteristics may be difficult to change, but enabling factors are highly mutable because the individual, community, or national policy alters the level of enabling factors for the individual (Bradley et al., 2002). Behavior change interventions are, therefore, more effective when targeted at highly mutable factors rather than those with low mutability, like most predisposing factors.

This model was appropriate to use as the theoretical framework for the current study because it allowed me to examine both endogenous and exogenous factors that influence an individual's medicine compliance behavior. Predisposing factors in medication adherence are largely similar to those of any level of health access (i.e., socio-cultural factors, such as health beliefs, and social support affect the likelihood of adherence; Atinga et al., 2018). Enabling factors, such as income and health insurance status, as well as logistical considerations, such as the availability and accessibility of medicines, impact adherence. Many interventions to encourage adherence are aimed at

enabling factors to the exclusion of predictive and need factors (Bradley et al., 2002). Need factors explain the high adherence level of acute illness medication relative to chronic disease medication (Miller, 2016). When the perceived need, evidenced by symptoms and pain, is alleviated, adherence levels decrease to the detriment of sustained disease control required for diabetes and HTN. The model, therefore, predicts a positive association between medication adherence and complication development and a positive relationship between nonadherence and insurance claims.

Understanding the predictors of medicine adherence is important to correctly target at-risk groups of patients and personalizing communication for maximum effectiveness (Matzke et al., 2018). Because this was a quantitative study using secondary data, I only examined exogenous factors, such as demographic and medical service utilization data available on the Cimas database.

Nature of Study

To answer the stated research questions, I carried out a quantitative, retrospective study. A quantitative research method is used to examine the relationship between the dependent and independent variables using statistical analysis (Creswell & Creswell, 2018). Results from a large, homogenous sample are generalizable to the population so that necessary interventions can be applied at the community level.

Secondary data from the Cimas Medical Aid Society's database that were collected for their operational use between 2015 and 2019 were analyzed in this study. Cimas Medical Aid Society is the largest private health funder in Zimbabwe. The society is over 70 years old and has accumulated a considerable amount of data its members'

health. The society also operates primary care clinics and pharmacies and has robust interlinked databases from which I was able to examine the health-seeking behavior of the study population.

To address the first research question, I used medicine adherence as the independent variable and complication development as the dependent variable. I used data from scheme members above 16 years old, which is the legal age of consent in Zimbabwe (see Zimbabwe National Statistics Agency, 2016). This mediating variable enabled me to focus on adults who can make their doctor's appointments, arrange for prescription refills, and understand their medication instructions. I was, therefore, able to study the adherence behavior of adults who have enough access to medicines and treatment information not to default. In the second research question, medicine adherence remained the independent variable and claims ratio was the dependent variable. I did not expect many patients to be in the lower age group because of the largely late-life onset nature of the chronic diseases. The claims ratio enabled me to analyse the health care costs of HTN and diabetes patients against other members of the scheme.

The quantitative study of the relationship between these variables provided statistically analyzable data to determine the association between the variables as evidence of how medicine adherence behavior affects the development of complications and claims ratio patterns of diabetic and hypertensive patients.

Literature Review

Over the last 2 centuries, life expectancy across the globe increased dramatically. Between 1950 and 2017, life expectancy increased from 48.1 years to 70.5 years for men

and from 52.9 years to 75.6 years for women (Dicker et al., 2018). Whereas in the 1900s, the leading cause of death was infectious diseases, such as pneumonia, tuberculosis, and gastrointestinal infection, there has been a shift towards NCDs as the leading cause of the death (Dicker et al., 2018; Gouda et al., 2019). According to the authors, this epidemiological transition is attributable to globalization and urbanization with the attendant changes towards sedentary lifestyles and a diet of refined sugars.

NCDs are a growing public health problem and have become the most common cause of morbidity and mortality, responsible for 71% of global annual deaths (World Health Organization, n.d.). While HIV/AIDS continues to be the leading cause of death in Zimbabwe, the U.S. Agency for International Development (2017) highlighted the increase of premature deaths due to NCDs, such as diabetes and HTN. The World Health Organization (2018) reported that in 2016, NCDs, led by HTN and diabetes, accounted for 33% of all deaths in Zimbabwe.

Literature Research Strategy

To understand the existing information related to my study topic, I conducted a literature search in peer-reviewed journals. The peer-review process ensures that scientific research publications meet quality and established research ethical standards in its reliability, replicability, trustworthiness, impact, and utility (Panda, 2019). I searched the Walden University Library, specifically the PubMed, ProQuest, and Google Scholar databases and search engines. Most of the articles I reviewed had been published in the last 5 years except where historical information was necessary. I used the following keyword terms for the literature search: *hypertension, high blood pressure, diabetes,*

medicine adherence or compliance or non-compliance, medical aid, medical insurance, claims ratio, and *claims cost.* My search yielded many articles, and I included 79 articles in the literature review.

HTN

The World Health Organization (2013) defined HTN as the elevated systolic and diastolic blood pressure over 2 consecutive days, with both readings above 140 millimetres of mercury (mmHg) and 90mmHg, respectively. The American Heart Association (2016), however, set the threshold lower at 130mmHg systolic and 80mmHg diastolic pressure. This difference in definitions has far-reaching implications on the prevalence of HTN. In the United States, the revision means that 31 million more people are classified as hypertensive (Messerli et al., 2018). HTN is believed to be an avoidable consequence of ageing (Alexander, 2017; Messerli et al., 2018); therefore, the definition should take age into account. Messerli et al. (2018) posited that using 100 plus half their age is a simple method for patients to self-monitor their blood pressure.

According to Alexander (2017), the classification of blood pressure for adults aged 18 years or older is generally as follows:

- Normal: systolic lower than 120 mmHg, diastolic lower than 80 mmHg
- Pre-HTN: systolic 120–139 mmHg, diastolic 80–89 mmHg
- Stage 1: systolic 140–159 mmHg, diastolic 90–99 mmHg
- Stage 2: systolic 160 mmHg or greater, diastolic 100 mmHg or greater

Another classification is by the aetiology of the condition, whether it is primary or secondary. Primary HTN has no clear cause and is thought to be linked to genetics, poor

diet, lack of exercise, and obesity (Alexander, 2017). Secondary HTN is caused by diabetes, kidney disease, and hormonal changes caused by pregnancy. Primary HTN accounts for 90%–95% of all diagnosed cases, and according to the World Health Organization (n.d.-a), risk factors of HTN include

- Age: blood pressure increases with age
- Race: more common in people of African heritage, with increased risk of complication of stroke and heart failure
- Family history: results in primary HTN through genetics
- Lifestyle factors, such as being overweight and obesity, tobacco and alcohol use, and high sodium and low potassium diet, are also risk factors of HTN

HTN is dubbed the "silent killer" due to its largely asymptomatic nature (Messerli et al., 2018). Where symptoms do occur, they are characterized by headaches, nosebleeds, arrhythmia, and chronic fatigue (Alexander, 2017). Complications of HTN are severe and can cause serious morbidity and death, including stroke, cardiac disease, renal failure, and blindness.

HTN is responsible for at least 45% of deaths due to heart disease and 51% of deaths due to stroke, and nearly 80% of the deaths occur in low- and medium-income countries (World Health Organization, 2013). HTN is the most prevalent cardiovascular disease in Zimbabwe with a prevalence rate of 30% (World Health Organization, 2013) and an estimated mortality rate of 21% (Mutowo, Mangwiro, et al., 2015). The comparatively lower rates in Zimbabwe are attributable to the asymptomatic nature of

HTN resulting in late diagnosis after significant damage to internal organs, such as the heart and kidneys (Mutowo, Mangwiro et al., 2015).

HTN Management

According to Alexander (2017)Management of HTN includes the following lifestyle changes:

- weight loss, which has been shown that 5–20 mmHG per 10 kilograms
- limiting alcohol to 15 and 30 millilitres for females and males, respectively, and reducing sodium intake to less than 100 mmol per day all help to reduce hypertension (Alexander, 2017)
- maintaining potassium, calcium, and magnesium levels,
- smoking cessation
- increased physical activity of at least 30 minutes of moderate intensity daily is also encouraged

When lifestyle modifications are inadequate to control HTN, pharmacotherapy of several drug options is recommended. Classes of medicines available are angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, or calcium channel blockers (Ministry of Health and Child Care, 2015). Angiotensin is a peptide hormone released by the liver and is important in blood pressure regulation. It is released as by the proteolytic action of renin on angiotensinogen and is converted into angiotensin II by angiotensin-converting enzyme. Angiotensin II binds to angiotensin receptors on the smooth muscle and constricts arteries and vein, resulting in increased blood pressure. Angiotensin-converting enzyme inhibitors act by blocking the conversion of angiotensin I into the

potent angiotensin II (Alexander, 2017). Angiotensin receptor blockers act by blocking receptors on the smooth muscles and inhibiting the vasocontraction effect of angiotensin II (Cranwell-Bruce, 2008). Calcium channel blockers cause smooth muscle relaxation by reducing the influx of calcium into muscle cells of cardiac myocytes, resulting in vascular relaxation.

According to the Ministry of Health and Child Care's (2015) "Essential Drugs List for Zimbabwe," the recommended treatment protocol for HTN is thiazides (i.e., hydrochlorothiazide) or calcium channel blockers (i.e., nifedipine or amlodipine) as first-line drugs, while the second-line agents are angiotensin-converting enzyme inhibitors (i.e., enalapril or lisinopril), angiotensin receptor blockers (i.e., losartan and atenolol) and alpha-blockers (i.e., prazosin and doxazocin).

Diabetes

Diabetes is a chronic metabolic disease characterised by hyperglycaemia (Zolotarova et al., 2016). The acute complications of diabetes include ketoacidosis, while long-term complications include stroke, cardiovascular disease, diabetic foot, renal damage, and retinopathy (Jingi et al., 2015; Spann et al., 2006; Zolotarova et al., 2016). Early symptoms of diabetes include frequent thirst and hunger and increased urination. Type 1 diabetes, previously known as juvenile diabetes, occurs where beta cells of the pancreas do not produce enough insulin due to loss of beta cells of the pancreas attributed to an autoimmune response of unknown origin (Jingi et al., 2015). Insulin is a hormone made by the Islets of Langerhans of the beta cells of the liver and is necessary for the absorption of glucose from the blood into tissues (Arambewela et al., 2018). Type 2

diabetes, previously known as adult-onset diabetes, results from a combination of insufficient insulin and insulin resistance and is caused by excessive weight and insufficient physical activity (American Diabetes Association, 2018a).

While the causes of Type 1 diabetes are unknown and therefore unpreventable, Type 2 diabetes is largely preventable by lifestyle changes, particularly dietary and physical activity changes (Jingi et al., 2015). Type 2 diabetes is the more common, constituting 90% of cases (Mazidi et al., 2016). Type 1 diabetes is managed by insulin injections, while Type 2 requires antiglycemic medicines. The Ministry of Health and Child Care (2015) recommended metformin as first-line treatment, which enhances skeletal muscle glucose uptake and inhibits intestinal glucose absorption. Glibenclamide or gliclazide are hypoglycaemic drugs recommended in poorly controlled diabetes to stimulate the beta cell insulin production (Ministry of Health and Child Care, 2015).

The International Diabetes Federation (2017) reported that about 425 million adults between the ages of 20 and 75 live with diabetes and project that number to increase to 629 million by 2045. According to their report, globally, US $727 billion was spent on diabetes in 2017, which is 12% of total health care expenditure. Diabetes is unequally distributed across different regions with an estimate that 80% of diabetic adults reside in low- to medium-income countries (International Diabetes Federation, 2017), with a prevalence of 5.2% for Sub-Saharan Africa and 4.5% for Zimbabwe (World Health Organization, 2018). However, Mutowo, Gowda, et al., (2015) opined that the figure is understated because of underdiagnosis due to the limited access to health centers in rural areas where 70% of the population in Zimbabwe resides.

HTN and diabetes are interrelated and codependent conditions that share a significant overlap in underlying risk factors and result in adverse health events, such as atherosclerotic cardiovascular disease and renal failure (Al-Azzam et al., 2021) Thurnes, 2018). Up to 75% of adults with diabetes also have HTN, and patients with HTN alone often show evidence of insulin resistance (Al-Azzam et al., 2021; Roberts et al., 2014; Yiu et al., 2018).

HTN and diabetes present a burden on global health care systems and general economies with direct costs emanating from expenditures on prevention, diagnosis, and treatment of the disease and its complications. Globally, the cost of diabetes is estimated at US $827 billion, comprising $174 billion for diabetes and $766 billion for HTN-related problems (Centers for Disease Cotrol and Prevention, 2019). Mutowo et al. (2016) and Patel (2016) posited that the cost of health care as one of the major determinants of access to quality health care. Mutowo et al. calculated that the cost of hospitalization due to diabetes and HTN in public hospitals in Zimbabwe is about $900 per person per episode, in a country that has average health spending of $79 per capita (The Global Economy, 2015). The costs are exacerbated where in-hospital care is required due to complication development and catastrophic health events, like myocardial infarction and stroke.

Medicine Adherence

Prevention of disease is the most cost-effective option and also facilitates health and wellness. However, once the disease has set in, there are different treatment protocols to control it and prevent the development of complications. Treatment can include

lifestyle modifications, especially diet and physical activity, and pharmacotherapy (Kleinsinger, 2018). HTN and Type 2 diabetes, once set in, are managed by medicine, and medicine adherence is a predictor of treatment outcomes (Zolotarova et al., 2016). The World Health Organization asserted that medicine adherence has more direct impact on chronic disease outcomes than the medicine itself (Boylan, 2017). However, the adherence rate in long-term treatment protocols is estimated at only 50%–60% (Marcum et al., 2013; Miller, 2016; Vogler, 2018). The effects of nonadherence are manifested in poor patient outcomes and increased health care costs. Turcu-Stiolica et al. (2017) linked poor medicine adherence to higher disease-specific and all-cause hospitalization and observed that adherence rate decreased with length of time the patient was on medication. HTN and diabetes are chronic illnesses that require lifetime adherence to prevent complication development. The results of Turcu-Stiolica et al.'s study are similar to those of Chen et al. (2019) who showed that the prestroke medication nonadherence rate in patients who were admitted for ischemic stroke was 75% and adherence was associated with enhanced admission HTN control and reduced occurrence of ischemic stroke. It is therefore imperative for health professionals to establish the promoters and barriers of adherence for effective interventions.

Sarfo et al., (2018), Vogler (2018), and Yang et al., (2016) posited that in designing effective interventions that promote treatment adherence, it is imperative to establish factors that influence patients' adherence behavior. In a qualitative study of patients who were on HTN medication, Sarfo et al. confirmed that patients with higher education and more knowledge on HTN were more likely to be nonadherent. The authors

did not use a theoretical framework to base their study on, therefore, there is a gap in understanding the reasons for noncompliance despite having information on the disease. Their results also showed poorer adherence in patients accessing medication at tertiary health institutions. Chen et al. (2014) demonstrated that while women had greater attendance at health care facilities, they tend to have lesser adherence than men and attributed the finding to cultural attitudes that frame women as caregivers and less as receivers of care.

Area of residence may also impact the rate of adherence because there may be information, access barriers, or local cultural issues to address. Kim et al. (2016) showed that adherence to diabetes treatment was higher in rural populations than urban populations, and this is important to Zimbabwe due to the skewed population distribution where 67% of the population resides in rural areas (Zimbabwe National Statistics Agency, 2016). The authors also showed that family history of diabetes was also associated with higher treatment adherence. Although the study was not based on a theoretical framework, the findings confirmed that knowledge of one's susceptibility and experience of the severity of the disease as given in the health belief model results in greater adherence.

Cost of medicine and refill logistics are commonly cited as major determinants of nonadherence (Cutler et al., 2018; Gupta et al., 2018; Lam & Fresco, 2015; Morgan & Lee, 2017; Ryan et al., 2014). Refill logistics are compromised in low-income countries and in the rural areas of these countries. Patients with multimorbidity, such HTN and diabetes, often forego medicines in one class or buy suboptimal amounts of medicines to

manage costs (Laba, 2016). The Government of Zimbabwe provides HTN drugs free to the user in public health institutions; however, adherence rates are still low (Mutowo et al., 2016). Mutowo, Mangwiro, et al. (2015) attributed this to refill logistical costs because health centers are usually far away from rural areas. The authors posited that the opportunity costs of household work and childcare may be too great, especially at nonsymptomatic stages. This finding confirms the effect of need factors of the Andersen's health care usage model as described by Li et al. (2016). Need factors are the immediate cause for seeking care, such as the experience of pain. The asymptomatic phase is therefore characterised by a low perceived need and patients are more likely to default on medication. As Sarfo et al. (2018) opined, it is imperative to establish the factors that influence patients' adherence behavior to design effective interventions.

Morgan and Lee (2017) showed that cost related nonadherence ranged from less than 3% to 18% in developed countries, while a similar measure could not be determined for low-income countries but can be reasonably assumed to be much higher. It is known and accepted that medical insurance increases access to health care. Choi (2018), Müllerschön et al. (2019) and Patel (2016) showed that people who have medical insurance are more likely to access medical care than those who do not. Although medical aid membership removes the cost barriers to medicine access, Belina et al. (2019) demonstrated that adherence to treatment protocols continues to be low within the population on medical insurance, especially among chronic disease patients.

Calculating Medicine Adherence

The ideal measurement to calculate adherence would be direct observation, which is however only feasible in hospital situations or where a caregiver is available to observe and record all incidences of medication taking. For research on large populations, indirect calculations are used as a proxy to direct methods. Two popular methods where adherence can only be measured from claims data have become popular with scientists are proportion of days covered (PDC) and medicine possession ratio (MPR). The MPR is a well-established method of calculating drug compliance in pharmaco-epidemiological studies The use of medicine claims data in MPR calculations is helpful in that this information is acceptably accurate, convenient, objective, noninvasive and relatively inexpensive to obtain when a large study population is needed (Jacobs et al., 2016). It is, therefore suitable for the calculation of the MPR as an indication of patient compliance with medication therapy (Slabbert et al. 2015; Jacobs et al. 2016). Whilst MPR has not been validated in Zimbabwe, it has been used in similar settings in South Africa (Jacobs et al., 2016; Slabbert et al., 2015). MPR is calculated as the ratio of the total number of days a patient has their medicine on hand to the number of days a patient is eligible to have the medicine on hand (Patel, 2018). The ratio is ideal at 100% where the patient has refilled all their medications on time, but adherence is set at 80%.

PDC is calculated by the ratio of the number of days the patient is covered by the medication to the number of days the patient is eligible to have the medication on hand (N. Patel, 2018). The PDC ratio provides a more accurate measure of medication adherence because it eliminates the possibility of being unreasonably elevated where a

patient has obtained medication in advance because it caps the ratio at 100% (Scott et al., 2005). PCD is also able to calculate adherence to multi-drug regimes. For this study, I studied adherence to at least one of the prescribed medicines for comparability between patients on single and multidrug regimes, and claims were counted on monthly submissions, therefore, I used MPR.

Zimbabwe Health care Overview

Historically, the Zimbabwe health care system was skewed towards colonial administrators while the local people only had access to second-grade facilities which were few and poorly equipped (Green, 2018; Kidia, 2018). At the attainment of independence in 1980, the new government pursued an aggressive health care provision program by adopting the primary health care approach which directed resources towards the low-income groups in the rural areas where 67% of its population resides (Zimbabwe National Statistics Agency, 2016). Health services became available within ten kilometres for 80% of the population (Zeng et al., 2018), and the country seemed well on the way to universal health coverage. The economic downturn of 2004 to 2009 was followed by a brief recovery period between 2009 and 2012 with renewed investment in health (Masuka & Sunanda, 2017). The economy declined again from 2017 and this has resulted in little investment in health exacerbated by debilitating skills flight. There is currently an impasse between health care workers particularly public hospital doctors and the government over conditions of service and the lack of equipment and consumables in hospitals. The impasse has resulted in an almost complete unavailability of medical services with a yet to be quantified loss of lives. Women constitute 52% of the population

of Zimbabwe (Zimbabwe National Statistics Agency, 2016) and are usually the primary caregivers, however, studies indicate that women are likely to take less care of themselves than the rest of the family (Jeihooni et al., 2019; Martinez-Marcos & Cuesta-Benjumea, 2014; Martinez-Marcos & De La Cuesta-Benjumea, 2015). Controlling for gender and age will allow me to examine their effect of adherence behavior and how they contribute to the wellbeing and health care costs between the sexes and age groups.

Health financing remains one of the contributors to Zimbabwe's poor outcomes. Health expenditure is yet to meet the Abuja Declaration of 2001 where African Union members pledged to allocate at least 15% of annual budgets to the health sector (Mhazo & Maponga, 2022; Shamu et al., 2017). Zimbabwe's health allocation has remained between 4% and 9% (World Health Organization, 2016). The average health expenditure per capita between 2010 and 2015 was US$77 (The Global Economy, 2015), and of this, government funding accounted for 18%, donors 19%, private companies and others 24%, and out-of-pocket 39% (World Bank, 2016). Of the population of 14 million, about 10% is covered on medical aid largely accessed through the employer as a work benefit (Zimbabwe National Statistics Agency, 2016). The schemes cover most health care services including medicines and hospitalisation to limits determined by the package level in line with prescribed minimum benefits cover. Prescribed minimum benefits are minimum benefits a scheme is expected to cover to ensure that members have access to health services regardless of the package they are on (Council for Medical Schemes, n.d.). Additionally, the major medical aid societies have ventured into and invested significantly in almost the total service provision value chain. Although members are not

precluded from using external service providers, they are not subjected to copayments at their institutions.

Claims Ratio

One of the key performance indicators of a medical aid society is its claims ratio, which is defined as the percentage of claims paid against the premiums earned (Belina et al., 2019). The industry best practice of a medical fund is 80% paid out to claims, 15% to administration and 5% reserves (Centers for Medicare & Medicaid Services, 2020). Below 80%, schemes may not be providing adequate cover for the subscriptions it collects (Cole & Karl, 2019), and when members claim above the 80% benchmark, it compromises the medical aid's ability to build reserves since the overhead is largely fixed. Inadequate reserves mean that the fund would not be solvent in the event of a surge in claims and is not able to reinvest. Medical disciplines with the highest value claims are hospitals, medicines, specialist doctor consultations, pathology, and radiology (Cimas Medical Aid Society, 2018). Members who utilize these services cost the fund more and so have a higher claims ratio than those who do not. Complications of diabetes and HTN result in higher health care utilisation as patients use more medicines, have more laboratory tests, require services of specialist doctors and are more likely to be hospitalised, resulting in higher claims ratio. The more high claimers a medical aid society has, the higher its overall claims experience.

Study Population

The study data was extracted from a population of the members of Cimas Medical Aid Society is Zimbabwe's oldest and largest private medical insurance company

founded in 1945. The membership of the society between 2014 and 2018 was about 200,000 people. Most members are employer-sponsored, although there has been a noticeable increase in direct-paying members due to the prevalent informalisation of the economy. Because of the employer sponsorship, principal members tend to be in the middle to high-income levels and would have attained at least secondary school education. Most employers cover a spouse and up to three children as beneficiaries. An average of 20% of the membership seek treatment in any given period (Cimas Medical Aid Society, 2018). The highest value disciplines are hospitalisation, medicines, pathology, industrial or private clinics and specialist doctor consultations. The top 5 common chronic diseases are HTN, arthritis, diabetes, hypercholesterolaemia, and psychosis. For this study, I will examine patient adherence to HTN and diabetes medication because of the interrelated causality and possible comorbidity between the two diseases.

Definitions of Terms

Claims ratio is the proportion of money paid out in claims for health care expenses relative to the premium paid in a given period (Belina et al., 2019).

Diabetes is defined as sustained fasting blood glucose level above 7mmol/l over two consecutive readings (American Diabetes Association, 2018b).

*Hypertension is c*onsistent high blood pressure above 130mm/hg systolic and 80 mm/hg diastolic over three consecutive readings (Egan, 2018).

Medical aid is a pooled fund for payment of health care expenses in return for monthly contributions or premiums (Council for Medical Schemes, n.d.)

Medicine Adherence is the extent to which a patient is compliant with a medicine regimen agreed with a health practitioner (Cole & Karl, 2019).

Medicine possession ratio is the proportion of days which a patient has access to their medicines as a fraction of the total number of days the patient is eligible to the medicines (Patel, 2018).

Complication development is defined as referral to a specialist for further management or hospitalization for stroke, coronary artery disease, and peripheral vascular disease, retinopathy, nephropathy, and neuropathy.

Assumptions

There are several aspects of the study for which I made indemonstrable assumptions. Because I used secondary data from the Cimas medical aid, I assumed that diabetes and hypertensive patients purchase all their drugs on medical aid, and the absence of a claim in a refill period was assumed as primary nonadherence. The assumption is necessary to support the assertion that the study population does not experience cost barriers to medicine access. For the claims ratio, I assumed that members access all their health care services through their medical aid schemes and that these costs are correctly captured on the Cimas database. I also assumed correct disease diagnosis and that diabetes and HTN medicine are life conditions, hence interruption or discontinuation of the medicine is nonadherence.

Scope and Delimitations

The scope of this study was to examine the role of medicine adherence in diabetes and HTN complication development and the contribution of these patients to the medical

loss of Cimas Medical Aid Society. The population was, therefore, limited to members of the scheme who have made at least three consecutive claims for an antihypertensive or diabetes medicine in the period 2015 to 2019. Participants were on the scheme as principal members or dependents and at least 16 years at the time of the first claim within the study period. One of the exclusion criteria was members under 16 years. I also excluded members who made less than three claims to rule out acute temporary diabetes and HTN. As this study is a secondary data analysis, I studied medicine adherence behavior and was not able to explore the mitigating factors for the behavior. The results of this study are potentially generalizable to Zimbabweans who are on medical aid schemes, as well as those in the middle- and high-income levels who may not experience cost barriers to access to medicines. The study population would be expected to share characteristics as these members of Zimbabwean society.

Significance of the Study

Medicine adherence is important in reducing HTN and diabetes complications which increase national health expenditure. Zimbabwe as a country has a significantly lower health budget than the Abuja Declaration recommendation of 15% of national budgets (Organization of African Unity, 2001). Reducing the burden of complication development could result in health savings which can be channelled towards other health needs, especially prevention activities which traditionally received significantly lower budgets than curative activities. With inadequate and often poorly resourced health care facilities, knowledge of enablers and barriers to medicine adherence may increase the

effectiveness and sustainability of self-care and reduce pressure on the health infrastructure.

Medication adherence is a predictor of treatment outcomes and is the mainstay of chronic disease management (Chen et al., 2019; Laba, 2016). Although medicine adherence has been studied in various environments globally, there is no literature on the Zimbabwean context, and this study will be significant in providing the necessary information to aid policy formulation and health services planning. There is need to increase the level of health education in general and medicine adherence in particular, in the community due to the high country disease burden, and to foster social change towards a more health ownership culture for the prevention and control of both infectious and non infectious diseases (Fertman & Allensworth, 2016). This study was, therefore, significant in providing evidence-based information on the importance of patient ownership of their health in adhering to prescribed treatment protocols which include their medicine regimes. It contributes to Zimbabwe information base on the compliance behavior of Zimbabweans and the subsequent contribution of that behavior in complication development. Medicine compliance behavior has largely been studied as a function of cost (Gupta et al., 2018; Laba, 2016; Morgan & Lee, 2017; Patel, 2016), and non cost related behaviors are ill-understood. Zimbabwe is working to achieve universal health coverage for its population by setting up a national health insurance scheme which will ensure access to minimum health care for all by eliminating cost barrier. The health behavior of a population already on health coverage may, therefore, be a predictor of likely behaviors when access for the general populace is guaranteed. Mitigatory activities

for noncompliant behavior can then be planned at the beginning to increase the likelihood of citizens benefiting from the scheme and reducing medicine wastage.

For medical aid companies, the results of the study may be significant in quantifying the cost of HTN and diabetes complications and assist in financial planning and forecasting adequate reserves requirements. As public health systems are refocussing from curative to preventive medicine, the overall social change envisaged is a healthier community with reduced health care costs and the savings would allow for greater investment into disease prevention.

Summary

In Section 1, I illustrated that hypertension and diabetes are important public health issues on which significant expenditure is made in the diagnosis and care of patients. I also highlighted the prevalence of HTN and diabetes, across the world and in Zimbabwe particularly. Disease prevention is the best and most cost-effective management strategy; however, medication is necessary where the diseases have set in. It is imperative for patients to adhere to their medicines to avoid complication development which leads to poorer outcomes and greater health spend. Previous authors have demonstrated that medicine adherence is largely impeded by cost in poorer communities who are not on medical aid and that non cost related adherence is also prevalent. Most literature focuses on the unaffordability of medicine, and there is a dearth of information on non-cost related nonadherence in Zimbabwe. Scholars have also shown that HTN and diabetes complications result in poorer health outcomes and higher health spend however, there is little information on the claims pattern of chronic disease patients in Zimbabwe.

Further research was necessary to fill these gaps and I hope to find possible answers by the end of this study.

In Section 2, I will describe the research design as well as have an in-depth analysis of the study population and the data set which I analysed. I will also discuss the methodology, including sampling methods, data analysis techniques as well as ethical considerations for the study.

Section 2: Research Design and Data Collection

The purpose of this study was to determine the association between treatment adherence, the development of complications, and the cost of care in diabetes and HTN patients who have medical aid coverage. In Section 1, I described the problem of medicine nonadherence as a threat to the effective management of diabetes and HTN globally, in Southern Africa, and Zimbabwe. I also reviewed the extant literature for current knowledge on the subject and identified gaps to address with this current study. The research questions and associated hypotheses were provided. In Section 2, I describe the execution plan of the study to include the research methodology, design, and the data collection and sampling methods. I also describe possible threats to the validity of the study and the ethical considerations made in its execution.

Research Design and Rationale

The purpose of an effective research design is to develop a framework to enable the researcher to obtain accurate and unbiased insights into the research questions (Creswell & Creswell, 2018). I employed a quantitative, retrospective design using secondary data analysis. In a retrospective record review, the investigator starts with the exposure and other variables at baseline and then measures the outcome during the follow-up period. The design gives an analysis of the measure of exposure (in the case of this study, medicine adherence) and tracks the development of outcomes (i.e., complications and claims cost) during the study period (i.e., 2015–2019). A retrospective cohort study can be completed fast and is relatively inexpensive compared with a prospective cohort study (Creswell & Creswell, 2018; Setia, 2016). In this study, I

sectioned the population by age at a cut-off of 16 years old. The qualifying members were further selected based on whether they bought HTN or diabetes prescription for 3 consecutive months at baseline and data followed through for the 5-year study period. I used quantitative analysis because it allowed for the statistical analysis of data in the study period to draw objective conclusions from.

Medicine adherence was the independent variable and complication development and claims ratio were the dependent variables. I controlled for age and gender because both variables have previously been associated with both medicine adherence and complication development (Atinga et al., 2018; Chen et al., 2014; Roberts et al., 2014; Yang et al., 2016). It was important to control for these variables so that they did not become confounders by distorting the interpretation of the results. The effect of confounding variables can be limited by randomisation, restriction or matching(Creswell & Creswell, 2018). For this study, I used purposive sampling, so randomization was not applicable.

Methodology

Population

The study population for this study were members of the Cimas Medical Aid Society between the years 2015 and 2019, including both principal members and dependents who were either employer or self funded and ranged in age from new borns to persons 65 years and older. The population was made up of approximately 200,000 scheme members. One of the tenets of a medical aid scheme is that the relationship is long term, and lifetime memberships are not uncommon, unlike medical insurance

schemes where contracts are renewed annually (Musich et al., 2015). The data I used were collected as part of the member registration on joining and the subsequent usage of the medical scheme. Health behavior was reflected in the claiming pattern for the different health care services accessed by the members. I chose the period of 2015 to 2019 because during this period the society had a stable membership and robust information system, so I expected the data to be more complete and accurate. The population is in the middle- to high-income bracket because medical aid in Zimbabwe is largely employer funded. The members may be actively employed or retired or are dependents of an employed or retired family member.

Sampling and Sampling Methods

I used nonprobability or purposive sampling because I studied all scheme members who met the inclusion criteria. Purposive sampling is a method in which samples are selected based on meeting a criterion set by the researcher's judgement and does not give all members of the population equal chances of being selected (Creswell & Creswell, 2018). I chose purposive sampling because it enabled me to focus on subjects of interest defined by their unique characteristic, which was a purchase of either diabetes or HTN medicines. Because the data set was small, I included all the diagnosed patients in the study.

Sampling Frame

My sampling frame was defined by the characteristics I considered for a subject to be included or excluded from selection. Since I used purposive sampling, the inclusion and exclusion criteria were well defined.

Participants were included in the study if they were members of Cimas Medical Aid Society between 2015 and 2019 who were above the age of 16 years old and had made at least three consecutive monthly claims for HTN and diabetes medicines.

Participants were excluded from the study if:

- they made less than three prescription claims in their first year of treatment
- they were already under specialist care for pre-existing HTN or diabetes complications in January 2019.
- they had an interrupted medical aid membership from January 2015 to December 2019
- unexplained or unrelated death

Data Collection Methods

I used electronic archival data from the Cimas Medical Aid Society database from the period 2015 to 2019. These data were collected as part of the medical aid registration process and subsequent updates on modifiable demographic data, such as place of residence. Medical usage data, such as the medicines purchased, referral for further management, and cost of medical care, were deduced from the medical claims information submitted to the medical aid society. The data extracted from the database were claim number, line number, member number, current age, suffix, sex, amount claimed, amount paid, shortfall, specialty code, description, date received, process date, pay date, service date, tariff code, quantity, referral, package, tariff amount, pay who, modifier string, shortfall reason, and provider type. I applied for and was granted access

to the database by the medical aid society. The definitions of the information collected are given in Table 1.

Table 1

Definitions of Data

Variable	Definition
Claim number	Is the count of the claim relative to total claims submitted in for the defined period
Line number	Is the count of the claim of the same type submitted in the period relative to total claims
Member number	Is the six-digit random number assigned to the members at data source in the database for identification
Current age	Is the age of the member at the time of claim submission
Suffix	Identifies and differentiates the dependents on the same member account
Sex	Identifies members' gender as either male or female
Amount claimed	The money a member is claiming for medical services or products received
Amount paid	The amount the medical aid awards to the claim submitted according to pre-set pay-out rules
Shortfall	The difference between the amount claimed and the amount paid which is met by the member
Speciality code	Identifies the different medical disciplines
Description	Nature of the services or products received
Date received	Date the claim was received by the funder
Process date	Date the claim was adjudicated and ready for payment
Pay date	Date money due to the member was paid out via agreed payment methods
Service date	Date the service or product being claimed for was received
Tariff code	The code for the identifying the service or product received
Quantity	The number of discrete services or items the member received
Referral	The original point of contact by the patient who referred for specialist service

Power Analysis

The power of a study is defined as its ability to detect an effect and avoid Type II error (i.e., the probability that it correctly rejects the null hypothesis; Creswell & Creswell, 2018). Although I expected to use all the HTN and diabetes patients for the sample, I still needed to determine that the study was not under- or overpowered to obtain

credible results. A small sample size may not be able to detect small effects; therefore, the results may not be generalizable on the population, while too large a sample may be too expensive to collect (Bell et al., 2012). This study was a retrospective study in which I intended to identify contributing factors to the development of complications, such as stroke, in patients who did not adhere to medication on comorbidities in the period of 2015–2019. Previous studies have shown that nonadherence to medication with an average prevalence of $\pi = 50\%$ was the main contributing factor to the complications (Hurst et al., 2015; Kleinsinger, 2018; Jacobs et al., 2016). I assumed the nonadherence to have a 0.1 correlation with the other factors to the development of complications. Previous studies have also shown that in general, if nonadherence was not a significant factor, the proportion of individuals who developed complications was about 70%, H0: $Pr(Y = 1|X = 1$; Getenet et al. 2019; Mugwano et al. 2016).

A truly representative sample is usually preferred, but the population of this study was relatively small and allowed for the inclusion of the entire population by use of an existing database with no further effort required for the data collection. I used the whole database and conducted a post hoc power analysis to determine the extent of its reliability in terms of the smallest effect size detectable. The study was retrospective where the patient records already existed in a database known to contain about 200,000 patients. Given the previously reported 50% average prevalence of nonadherence and the general 70% of patients that develop complications, I asserted that in the absence of financial barriers to medicine access, the effect of adherence to medication would likely decrease the risks of developing complications to less than the reported 70%. Hence, the aim of the

power analysis, in this case, was to determine the smallest possible effect size (i.e., smallest percentage decrease below 70%) and, in terms of odds ratios, that the available databases size can detect if it indeed existed. I also intended to accommodate a maximum of 5% Type I error (i.e., 95% confidence of the conclusion) and a maximum of 20% Type II error (i.e., 80% power of test). Using GPower software, Version 3.1.9.7 for sample size calculations, I calculated that the available 200,000 patients would detect an effect size (odds) of 0.953 about 94.4% of the time. That is, with the 200,000 patients, I would detect at least a 4.7% chance of decrease in the complications due to nonadherence. This was equivalent to detecting a decrease of at least 1% in the complications from the reported 70% due to adherence about 94.4% of the time with a 95% confidence level. All the tests were conducted at a 5% level of significance.

Instrumentation

Data collection instruments are selected based on the type of data to be collected, the practicality of use, and the resources required for collection (Creswell & Creswell, 2018). I used archival data collection, which used secondary data already existent as paper or electronic files. These data may have been collected as part of a research or in the normal course of business. I used these data because they were available, which saved on time and resources. Because members access health care through medical aid, there was the possibility of accessing more medical insights from the data than I had envisaged for research. The archival data instrument was easily accessible because the necessary data access and use permissions were granted.

Operationalization of Constructs

I used medicine adherence as the independent variable. I calculated adherence using MPR, which denotes the number of days in a month a patient had their medication available as derived from medication claims. The cut-off for MPR was 80%, where patients above the cut-off were considered adherent and those below 80% nonadherent. Complication development was the first dependent variable, and it was defined as a claim for further management for renal, optical, or cardiovascular problems or hospitalization for these issues or all-cause hospitalization. Claims ratio, the other dependent variable, was defined as the percentage of claims costs incurred for disease-specific and all-cause health care in relation to the contributions the patient has made. The operationalization of constructs and their cut-offs are summarized in Table 2.

Table 2

Operationalization of Constructs

Variable	Level of Measurement	Coding
Medicine possession ratio (independent variable)	Ordinal	1 =< 80% 2 => 80%
Complication development (dependent variable)	Nominal	1 = yes 2 = no
Claims Ratio (dependent variable)	Nominal	1 =< 80% 2 =≥ 80%
Gender	Nominal	1 = female 2 = male
Age	Scale	1 = 16–30years 2 = 31–40years 3 = 41–50years 4 = 51–60 years 5 = 61–70 years 6 = 71–80 years 7 => 80 years

Data Analysis Plan

The research questions and associated hypotheses that guided this study were:

Research Question 1: What is the extent of the association between medication adherence and complication development in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years of age and have been on treatment for more than 1 year, controlled for gender and age?

$H_0$1: There is no statistically significant association between medication adherence and complication development in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years old of

age and have been on medication for more than 1 year, controlled for gender and age?

$H_1$1: There is a statistically significant association between medication adherence and complication development in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years old and have been on medication for more than 1 year, controlled for gender and age?

Research Question 2: What is the extent of the association between medication adherence and claims ratio in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years old and have been on medication for more than 1 year, controlled for gender and age?

$H_0$2: There is no statistically significant association between medication adherence and claims ratio in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years old and have been on medication for more than 1 year, controlled for gender and age?

$H_1$2: There is a statistically significant association between medication adherence and claims ratio in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years old and have been on medication for more than 1 year, controlled for gender and age?

Before using the dataset, I cleaned the data for use. Data cleaning is the process of identifying and correcting incomplete or inaccurate data before analysis (Bell et al., 2012). I did not envisage that the dataset would require extensive cleaning as it was

claims information, which was used for medical reimbursement, however, the society used different claims processing software in the period and some data was incomplete or duplicated, particularly from 2015 to 2018. For the management and analysis of statistical data, I used the IBM Statistical Package for the Social Sciences (SPSS) software Version 28. My analysis started with univariate analysis, which included frequency and percentage distributions to analyse demographic characteristics of population and sample, its distribution and dispersion of the data around the mean. I established appropriate assumptions of data to select the correct statistical methods. My independent variable in both research questions was medicine adherence which was a binary variable. The first dependent variable (complication development) was also a binary variable, therefore, to measure the association between medicine adherence and complication development, I used the chi-square statistic for bivariate analysis. The independent variable in the second research question was claims ratio which was also a nominal value at a cut of 80% for low and high values. I also use chi-square to study the association between claims ratio and medicine adherence. Studies have shown that both complication development and claims ratio are associated with sex and age (Chen et al., 2014; Sarfo et al., 2018; Yang et al., 2016; Jager et al., 2008), so I controlled for both of these variables using binary logistic regression in the multivariable analysis. Data for hypertensive, diabetic, and comorbid patients was analysed separately, and compared against each other. Table 3 summarizes the data analysis plan for each research question.

Table 3

Statistical Procedures per Research Questions and Hypotheses

Research Question	Hypothesis (H_a)	Variables	Statistical procedures/analysis
RQ1: What is the extent of the association between medication adherence and complication development in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years of age and have been on treatment for more than one year, controlled for gender and age?	H_a: There is a statistically significant association between medication adherence and complication development in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years old and have been on medication for more than one year, controlled for gender and age?	Independent Variable: Medicine adherence DV: Complication development	Binary logistic regression
RQ2: Quantitative: What is the extent of the association between medication adherence and claims ratio in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years old and have been on medication for more than one year controlled for gender and age?	H_a: There is a statistically significant association between medication adherence and claims ratio in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years old and have been on medication for more than one year, controlled for gender and age?	Independent Variable: Medicine adherence Dependent Variable: Claims ratio	Binary logistic regression

Threats to Validity

Validity is the extent to which a study accurately measures what it is intended to measure, that is, how accurately research results reflect the real properties in the physical or social world (Creswell & Creswell, 2018). It measures the appropriateness of the design and the methods of the research. Internal validity is the extent to which the study can measure the truth about a population, that is, the extent to which the study is not affected by methodological errors (Patino & Ferreira, 2018). Methodological errors include errors in sample selection, measurement errors, not controlling for a major variable, or sample attrition. I endeavoured to use robust instruments and made provisions to account for the confounding variable of age and gender to ensure internal validity. My study had limited sample selection errors as I used a total stratified sample approach. The archival instrumentation enabled me to use data which had been cleaned out for the purposes for paying claims and therefore was expected to be complete and error-free. Noncommunicable diseases have been shown to have greater incidence with the age and gender, I therefore, controlled for both variables so that any association observed can be attributed to medicine adherence and complication development.

External validity evaluates the extent to which the results are generalisable to a larger population and other contexts different from the study context (Patino & Ferreira, 2018). It is affected by such factors as population characteristics, the research environment and time of study. To address external validity, I used a total sample of hypertension and diabetes patients who met the study criteria (23, 303 patients), eliminating sampling bias. The data I used were from existent records of health-seeking

behavior in the participants' normal consumption of health services which increased external validity.

Ethical Considerations

Appropriate ethical considerations were given throughout the execution of this study. Data to be used was from the Cimas Medical Aid Society database. I applied for and obtained permission to use the data. The company provided the data set after all personal identifiers such as names, membership numbers, and employer identity have been removed and replaced with generic codes. Data were treated confidentially and stored in a secure encrypted hard drive where only I and a statistician had access. The data was used for the current study and will be destroyed 5 years after this study has been published. The necessary research approvals for the study were obtained from the Walden University Institutional Review Board (IRB 10-21-20-0656879), and the Medical Research Council of Zimbabwe (MRCZ/A/2688).

Summary

Careful planning is the hallmark of credible research. A well-planned research produces both reliable and credible results and can be produced in various settings. In Section 2, I described how I carried out the research. I used a quantitative cross-sectional design using secondary data collected from the Cimas Medical Aid Society database. The target population was members of the Society, and the sample was all members over the age of 16 who are on treatment for either hypertension or diabetes. I used SPSS software for data analysis. In Section 3, I described the data and results from the analysis.

Section 3: Presentation of the Results and Findings

With this study, I aimed to determine the extent of the association between medicine adherence, complication development, and the relative cost of care in patients on medical insurance cover in Zimbabwe. The research questions and the associated hypotheses that guided this study were:

Research Question 1: What is the extent of the association between medication adherence and complication development in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years of age and have been on treatment for more than 1 year, controlled for gender and age?

$H_0$1: There is no statistically significant association between medication adherence and complication development in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years old and have been on medication for more than 1 year, controlled for gender and age?

$H_1$1: There is a statistically significant association between medication adherence and complication development in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years old and have been on medication for more than 1 year, controlled for gender and age?

Research Question 2: What is the extent of the association between medication adherence and claims ratio in diabetic and hypertensive members of Cimas

Medical Aid Society who are above 16 years old and have been on medication for more than 1 year, controlled for gender and age?

$H_0$2: There is no statistically significant association between medication adherence and claims ratio in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years old and have been on medication for more than 1 year, controlled for gender and age?

$H_1$2: There is a statistically significant association between medication adherence and claims ratio in diabetic and hypertensive members of Cimas Medical Aid Society who are above 16 years old and have been on medication for more than 1 year, controlled for gender and age?

To answer these questions, I performed statistical analysis using IBM SPSS Statistics Data Editor, Version 28 software, starting off with descriptive statistics for the 5-year period from 2015–2019 to get the general trend of the two conditions. For the inferential statistics, I focused on 2019 only because I had the complete claims data for the patients of interest from this year and also because they were the most recent data.

Data Collection

For this study, I used archival data from the Cimas Medical Aid Society database from the period 2015-2019. These data were collected as part of the medical aid registration process and subsequent updates as recorded. I obtained medical usage data, such as the medicines purchased, referral for further management, and cost of medical care, from the medical claims lodged with the society. The specific data extracted from the database were claim number, line number, member number, current age, suffix, sex,

amount claimed, amount paid, shortfall, specialty code, description, date received, process date, pay date, service date, tariff code, quantity, referral, package, tariff amount, pay who, modifier string, shortfall reason, and provider type.

Demographics

Cimas Medical Aid Society had an average membership of 188,115 members from 2015 to 2019. The number of diabetic and hypertensive members were 11,728 (2015); 12,102 (2016); 13,267 (2017); 14,739 (2018); and the highest being 16,560 in 2019. Hypertensive and diabetic patients constituted on average 11% of the membership in the 5 years. Table 4 shows that the combined prevalence of two diseases was on average 7.3%, progressively increasing in the 5 years under study.

Table 4

Patients with Diabetes and HTN

Year	Total Membership	Diabetic and HTN members	Diabetes/ HTN Frequency %
2015	184,184	11,728	6.4
2016	182,993	12,102	6.6
2017	181,671	13,267	7.3
2018	189,367	14,739	7.8
2019	202,358	16,560	8.2

Age Distribution (Average 2015–2019)

As shown in Table 5, the age distribution of the Cimas membership is in line with the national age distribution, which reflects an overall young population. The 0–15 age

group constitutes 22.6% of the membership; however, it is 41.3% of the national population (Nyoni & Bonga, 2017). This a reflection of the Zimbabwean workforce and their dependents. The workforce has less 0–15-year-old dependents than are in the general population. The largest age group is the 16-40-year old group, reflecting the productive age group entering employment.

Table 5

Age Distribution of Cimas Members

Age Group	Frequency	Percent	Cumulative Percent	Zimbabwe	Zimbabwe Cumulative
0–15	45,710	22.6	22.6	41.3	41.3
6–40	92,128	45.5	68.1	40.5	81.8
41–60	46,764	23.1	91.2	13.5	95.3
61–80	15,046	7.4	98.7	4.2	99.6
80+	2,710	1.3	100.0	0.4	100

Table 6 reflects that the burden of the two chronic diseases is largely in the 41–60 and 61–80-year-old age groups, constituting on average 80% over the study period, with a worrying 60% increase in the younger 16–40-year-old age group, from 7.6% in 2015 to 13.0% in 2019. This may be attributable to higher disease incidents or higher diagnosis rates as health care and health education become more accessible.

Table 6

Age Distribution of Diabetes and HTN

	2015		2016		2017		2018		2019	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
16–40 Years	891	7.6	1,029	8.5	1,353	10.2	1,621	11.0	1,822	13.0
41–60 Years	4,973	42.4	5,252	43.4	5,983	45.1	7,001	47.5	7,866	48.5
61–80 Years	4,550	38.8	4,562	37.7	4,723	35.6	4,952	33.6	5,564	31.8
81+ Years	1,314	11.2	1,259	10.4	1,207	9.1	1,179	8.0	1,325	6.8
Total	11,728	100.0	12,102	100.0	13,267	10.2	14,739	100.0	16,560	100.0

Gender Distribution (Average of 5 Years)

The distribution by gender shows that Cimas Medical Aid Society had 51.2% females and 48.8% males, in line with the national distribution of 52.3% and 47.7%, respectively (Central Statistical Office, 2015). Table 7, however, shows a disproportionate burden of chronic diseases in females (58.7% average) than in males (41.2% average).

Table 7

Gender Distribution of Diabetic and HTN Members

	Male		Female		Total	
Year	Frequency	Percent (%)	Frequency	Percent (%)	Frequency	Percent (%)
2015	4,875	41.6	6,849	58.4	11,728	100.0%
2016	4,650	41.5	7,080	58.5	12,102	100.0
2017	4,963	41.2	7,801	58.8	13,267	100.0
2018	5,274	41.2	8,667	58.8	14,739	100.0
2019	5,654	41.3	9,721	58.7	16,560	100.0

Tables 8 and 9 show that the average adherence rate for diabetes and hypertension were 47.0% and 52.2%, respectively, with progressive increase in the years under study.

Table 8

Adherent and Nonadherent Members

	Adherent		Nonadherent		Total
Year	Frequency	Percent (%)	Frequency	Percent (%)	
2015	1,244	43.3	1,341	46.7	2,872
2016	967	45.9	992	47.1	2,107
2017	1,225	47.8	1,287	50.2	2,563
2018	1,456	49.3	1,498	50.7	2,954
2019	1,590	48.8	1,668	51.2	3,258

Table 9

HTN Adherent and Nonadherent Members

	Adherent		Nonadherent		Total
Year	Frequency	Percent (%)	Frequency	Percent (%)	Frequency
2015	4,456	49.9	4,474	50.1	8,930
2016	4,747	51.1	4,542	48.9	9,289
2017	5,073	53.9	4,339	46.1	9,412
2018	5,365	53.6	4,644	46.4	10,009
2019	6,984	52.5	6,318	47.5	13,302

Chronic Cimas Members Developing Complications

Table 10 shows that an average of 48.8% chronic disease patients developed complications and sought specialist management. This can be attributed to the low adherence rates observed above. However, there is an encouragingly steady decline in complication over the years in tandem with the corresponding increasing adherence rates.

Table 10

Diabetic and HTN Patients who Developed Complications

	Yes		No		Total	
Year	Frequency	Percent (%)	Frequency	Percent (%)	Frequency	Percent (%)
2015	10,217	50.9	9,850	49.1	20,067	100.0
2016	9,360	48.9	9,792	51.1	19,152	100.0
2017	10,005	48.8	10,478	51.2	20,483	100.0
2018	10,101	46.4	11,665	53.6	21,766	100.0
2019	8,198	35.2	15,105	64.8	23,303	100.0

Claims Ratio Analysis

An average of 35.3% of the study sample had an adverse claims ratio, above the recommended 80% as demonstrated in Table 11, with the ratio reducing progressively over the study period.

Table 11

Claims Ratios 2015–2019

	=< 80%		> 80%		Total
Year	Frequency	Percent (%)	Frequency	Percent (%)	Frequency
2015	12,593	62.8	7,474	37.2	20,067
2016	12,349	64.5	6,803	35.5	19,152
2017	13,004	63.5	7,479	36.5	20,483
2018	13,993	64.3	7,773	35.7	21,766
2019	15,964	68.5	7,339	31.5	23,303

Research Question 1: Chi-Square Test for Association Between HTN Medicine Adherence and Complication Development (2019)

Table 12 shows the *p* value of < 0.001 in Pearson's chi-square. This value is less than the cut-off of p = 0.05 ; therefore, the null hypothesis that there is no association between medicine adherence and complication development is rejected. This means that there is an association between HTN medicine adherence and complication development.

Table 12

Chi-Square Test for Association Between HTN Adherence and Complications

	Value	*df*	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson chi-square	41.792	1	.000		
Continuity correction	41.379	1	.000		
Likelihood ratio	40.540	1	.000		
Fisher's exact test				.000	.000
Linear-by-linear association	41.790	1	.000		
N of valid cases	23,303				

Research Question 1: Chi-Square Test for Association Between Diabetes Medicine Adherence and Complication Development (2019)

In Table 13, running the same chi-square test for diabetes and complication development shows a *p* value of 0.181, which is greater than the designated value of *p* = 0.05; therefore, I failed to reject the null hypothesis. This means that there is no association between diabetes medicine adherence and complication development.

Table 13

Chi-Square Test for Association Between Diabetes Medicine Adherence and Complication Development

	Value	*df*	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson chi-square	1.788	1	.181		
Continuity correction	1.744	1	.187		
Likelihood ratio	1.784	1	.182		
Fisher's exact test				.183	.093
Linear-by-linear association	1.788	1	.181		
N of valid cases	23,303				

Research Question 2: Chi-Square Test Measuring Association Between HTN Medicine Adherence and Claims Ratio (2019)

The results of chi-square test to determine the association between HTN medicine adherence and claims ratio shows a value of $p < 0.001$, which is less than $p = 0.05$; therefore, the null hypothesis is rejected, meaning there is an association between HTN medicine adherence and the claim loss ratio (see Table 14).

Table 14

Chi-Square Test for the Association Between HTN Adherence and Claims Ratio

	Value	*df*	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson chi-square	376.533	1	.000		
Continuity correction	375.256	1	.000		
Likelihood ratio	496.755	1	.000		
Fisher's exact test				.000	.000
Linear-by-linear association	376.517	1	.000		
N of valid cases	23,303				

Research Question 2 Chi-Square Test Measuring Association Between Diabetes Medicine Adherence and Claims Ratio (2019)

The Pearson chi-square test for the association between diabetes medicine adherence and claims ratio shows a value of $p < 0.001$. Referencing a p value of 0.05, the null hypothesis is rejected, and therefore, there is an association between diabetes medicine adherence and claims ratio (see Table 15).

Table 15

Chi-Square Test for the Association Between Diabetes Medicine Adherence and Claims Ratio 2019

	Value	*df*	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	632.827	1	.000		
Continuity Correction	631.977	1	.000		
Likelihood Ratio	686.570	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	632.800	1	.000		
N of Valid Cases	23,303				

Research Question 1: Association Between HTN Medicine Nonadherence and Complication Development Using Binary Logistic Regression (2019)

Binary logistic regression to measure association shows that nonadherent HTN patients have a 1.428 chances of complication development than adherent patients. It also showed that nonadherent females are 1.149 times more likely to develop complications than males. I used the 16-40 years age group as the reference age for analysis. Nonadherent members in the age groups 41-60years, 61-80years, 80+years were respectively 2.795, 3.848, and 2.222 times more likely to develop complications than the 16–40-year age group (Table 16).

Table 16

Binary Logistic Regression for the Association Between HTN Medicine Adherence and Complications 2019

		B	S.E.	Wald	*df*	Sig.	Odds ratio	Odds ratio Lower	Odds ratio Upper
Step 1[a]	HTN nonadherence (ref: adherence)	.356	.063	31.951	1	.000	1.428	1.262	1.615
	Gender (ref: Males)	.139	.029	23.784	1	.000	1.149	1.087	1.216
	Age (Ref:16-40yrs)			722.900	3	.000			
	41-60	1.028	.064	256.431	1	.000	2.795	2.465	3.170
	61-80	1.347	.056	586.568	1	.000	3.848	3.450	4.291
	80+	.798	.057	197.940	1	.000	2.222	1.988	2.483
	Constant	-1.165	.134	75.213	1	.000	.312		

Research Question 1: Association Between Diabetes Medicine Nonadherence and Complication Development Using Binary Logistic Regression 2019

Table 17 shows that while nonadherent and adherent diabetic members had almost similar likelihoods of complication development at odds ratio of 0.993, females were 1.145 times more likely than males. The age groups 41-60 years, 61-80 and 80+ years had higher odds ratios at 2.824, 3.856, and 2.205, respectively, than the 16–40-year age group.

Table 17

Binary Logistic Regression for the Association Between Diabetes Medicine Adherence and Complications 2019

								95% C.I.for ODDS RATIO	
		B	S.E.	Wald	*df*	Sig.	Odds Ratio	Lower	Upper
Step 1[a]	Diabetes nonadherence (ref: adherence)	-.007	.034	.041	1	.840	.993	.930	1.061
	Gender (ref: Males)	.135	.029	22.409	1	.000	1.145	1.082	1.210
	Age (Ref:16-40yrs)			731.501	3	.000			
	41-60	1.038	.064	259.798	1	.000	2.824	2.489	3.204
	61-80	1.350	.056	588.709	1	.000	3.856	3.458	4.300
	80+	.791	.057	194.544	1	.000	2.205	1.973	2.464
	Constant	-.457	.079	33.579	1	.000	.633		

Research Question 2: Association Between HTN Medicine Nonadherence and Claims Ratio Using Binary Logistic Regression (2019)

Nonadherent HTN patients had 2.516 chances of an adverse claims ratio than adherent patients. Female nonadherent HTN patients had a 1.070 times greater chance of an adverse claims ratio than males. The older age groups also had higher chances of unfavorable claims ratios than the 16-40 age group (3.483, 4.190, 1.780, respectively), as shown in Table 18.

Table 18

Binary Logistic Regression for the Association Between HTN Adherence and Claims Ratio

		B	S.E.	Wald	*df*	Sig.	Odds Ratio	Odds Ratio Lower	Odds Ratio Upper
Step 1[a]	HPT nonadherence (ref: adherence)	.923	.041	517.194	1	.000	2.516	2.324	2.725
	Gender (ref: Males)	.067	.030	5.175	1	.023	1.070	1.009	1.134
	Age (Ref:16-40yrs)			846.254	3	.000			
	41-60	1.248	.084	221.086	1	.000	3.483	2.955	4.106
	61-80	1.433	.077	343.614	1	.000	4.190	3.601	4.876
	80+	.577	.080	51.806	1	.000	1.780	1.522	2.083
	Constant	-3.562	.107	1113.890	1	.000	.028		

Research Question 2: Binary Logistic Regression for the Association Between Diabetes Medicine Adherence and Claims Ratio

In Table 19, the likelihood of adverse claim ratio in diabetes patients was significantly higher at odds ratio of 8.301 than adherent groups, with very little difference between the genders (*OR=1.093*). The likelihood increased significantly with age, with odds ratios of 3.831, 4.251, and 1.789 in the age groups 41-60 years, 61-80 year age group, and 80+ were respectively compared to the 16–40-year age group.

Table 19

Binary Logistic Regression for the Association Between Diabetes Medicine Adherence and Claims Ratio

								95% C.I.for ODDS RATIO	
		B	S.E.	Wald	*df*	Sig.	Odds Ratio	Lower	Upper
Step 1[a]	Diabetes nonadherence (ref: adherence)	2.116	.135	244.724	1	.000	8.301	6.367	10.821
	Gender (ref: Males)	.089	.030	9.036	1	.003	1.093	1.031	1.158
	Age (Ref:16-40yrs)			889.196	3	.000			
	41-60	1.343	.084	258.193	1	.000	3.831	3.252	4.513
	61-80	1.447	.077	353.106	1	.000	4.251	3.655	4.944
	80+	.582	.080	53.076	1	.000	1.789	1.530	2.092
	Constant	-6.096	.280	473.725	1	.000	.002		

Summary

The purpose of this study was to determine the association between medicine adherence and the development of complications, and the claim ratio in diabetes and HTN patients who are on medical cover with Cimas Medical Aid Society. Statistical analysis from the health care usage data was performed for both descriptive and inferential analyses. The results of the chi-square analysis for Research Question 1 showed that there is an association between hypertension for medicine adherence and complication development, while the same could not be established for diabetes. Binary logistic regression for Research Question 1 showed that older nonadherent members are at least twice as likely to develop complications than the youngest age group 16–40-year-olds for both diabetes and HTN. For both conditions, nonadherent females were more at

risk of complications than males. For Research Question 2, an association between medicine adherence and adverse claims ratio was established for both diseases using the chi-square analysis. Binary logistic regression showed that nonadherent members had a higher likelihood of an adverse claim ratio than adherent members, with females higher than males. The claim ratio progressively worsened in the older age groups compared to the youngest age group.

In Section 4, I will review the findings of the study against the literature available, as well as discuss their implications for social change, and propose recommendations for future studies.

Section 4: Application to Professional Practice and Implications for Social Change

It is generally accepted and supported by literature that adherence to prescribed medicine reduces the chances of complications in chronic diseases, especially HTN and diabetes (Chen et al., 2019; Lam & Fresco, 2015; van Dulmen et al., 2007). I conducted this quantitative, cross-sectional study to determine the association between medicine adherence, the development of complications, and the claim ratio in diabetes and HTN patients who are members of a medical aid scheme in Zimbabwe.

Interpretation of the Findings

The first research question I sought to answer was whether there was an association between HTN and diabetes medicine adherence and complication development, manifesting as referrals for specialist attention from a general practitioner. For the second question, I determined whether there was an association between medicine adherence and medical costs as determined by medical claims cost on the insurance scheme.

Kleinsinger (2018) stated that medicine adherence is an important predictor of treatment outcomes in chronic disease patients. In this study, over the period of 2015 to 2019, average adherence rates of 47.0% and 52.2% for diabetes and HTN, respectively, were observed. These numbers are largely in line with the 50% to 60% range that has been recorded in the literature (Kleinsinger, 2018; Vogler, 2018). A recent comparison between Oman and U.S. adherence rates showed 48% and 45%, respectively (Ibrahim et al., 2021). Adherence rates of at least 80% are required to attain therapeutic efficacy (Carolina, 2022). The progressive increase in adherence for both diseases over the 5-year

period under study is encouraging, and interventions to continue the trend should be supported to increase the rates to at least the 80% required for medicine efficacy.

Chi-square analysis showed that while there was an association between HTN adherence and complication development, the same could not be established for diabetes. Further analysis revealed that almost half (48%) of chronic patients went on to develop complications, which is to be expected given the low adherence rates. These findings align with those of Hurst et al. (2015) who showed a higher propensity of patients with HTN and diabetes to develop complications even in monomorbid cases. No association between adherence and diabetes complication development was observed. This can be attributed to the complexity of the condition and the many factors that affect effective control. Wireno et al. (2021) demonstrated that diet and medicine adherence were the significant factors, while Mutowo et al. (2015), and Oladele et al. (2015) asserted that among social factors, poverty and level of education were significant contributors. Interventions to mitigate against diabetes complication development should focus not only on adherence to medicines but also on other aspects of the treatment regimens, such as diet and physical activity. The population of the current study would not experience cost barriers to medicines because they are on medical aid, bringing other social and lifestyle issues, such as purchase logistics, health beliefs, and physical activity, to the fore.

Although the study demonstrated that women are more likely to develop complications than men, the more significant determinant was age, with the likelihood at least doubling in the nonadherent older age groups compared to the youngest reference

age group for both diabetes and HTN. This finding aligns with other studies (Al-Azzam et al., 2021; Mulugeta et al., 2019) that stressed the importance of ensuring adherence support for seniors to prevent episodes of complications.

Claims ratio analysis revealed that 48% of chronic disease patients had an adverse claims ratio above 80% over the 5 years, an expected result given the subpar adherence rates and the high complication rate. This result confirms the findings of Adejumo et al. (2020) and Manns et al. (2019) who showed higher care costs in chronic disease patients. The chi-square test confirmed the association between medicine nonadherence and adverse claims ratios for both HTN and diabetes. Patients who did not adhere to the medicines were up to 4 times more likely to have an adverse claims ratio than the adherent group and that likelihood increased with age.

I analyzed the results of the current study against Andersen's behavioral model of health care use that posits that health care utilization is a function of predisposing, enabling, and need factors (see Andersen & Glaser, 1969; Li et al., 2016). Age and gender were confirmed as predisposing factors for complication development and adverse claims ratio due to increasing health care utilization. This means that health care workers and the Cimas Medical Aid Society should be targeting primary, secondary, and tertiary strategies, particularly on medicine adherence for women and older members above 40 years of age. Health literacy about the diseases and the recommended therapies is an enabling factor that influences health beliefs and can be enhanced by health education and promotion through constant and effective communication with patients.

Economic factors, such as income and health insurance status, have been identified as some of the most significant enabling factors for health care utilization (Kabir, 2021; Kim et al., 2020). For the study population, however, this barrier is effectively mitigated by medical aid, which covers the cost of the medicines. However, other attendant costs, such as transport for collection, the accessibility of pharmacies, and availability of medicines, are enabling factors affecting effective adherence. Nonadherence increased with age; therefore, interventions need to be particularly sensitive to older members.

Need factors were not directly demonstratable in the current study; however, previous studies have shown a positive correlation between acute health events episodes and medicine use. Miller (2016) asserted that the experience of pain explains the better adherence rate in acute rather than chronic conditions. This view may support the low adherence rates observed in the current study because some patients may stop taking their medicines if there is no sensation of pain or their pain has resolved. This is particularly dangerous in HTN, which is largely painless in the early stages and has thus been dubbed the “silent killer.”(Messerli. et al., 2018)

Limitations of the Study

While this study provides answers to the research questions on medicine adherence, complication development, and cost of care, there were some limitations. I used indirect methods to measure the personal behavior of medicine adherence by inferring behavior from medical aid claims history. While this tactic allowed me to analyze large amounts of data, the quantitative method used to analyze claims data does

not provide insights into the patients' underlying theories and health beliefs that influence their adherence behavior. Further researchers may look into using qualitative data to mitigate this limitation. Both dependent and independent variables were coded into broad nominal data classes. This process sacrificed the specific insights that might have been obtained from analysis of the spectrum of adherence and claims ratio data, which would have allowed for comparative analysis over time.

While a useful adherence indicator, MPR does not directly measure medicine usage, especially in older patients who may need assistance and reminders. While medicine possession may be high, actual use might be low. A patient may have bought their medicine for cash and not submitted a claim, which was misconstrued as nonadherence since claims data would not captured in such a case. These limitations do not invalidate the results but provide insight for further research.

Lastly, the Cimas Medical Aid Society database had some incomplete data for the years between 2015 and 2019, so I used only 2019 data to perform logistic regression for the research questions. The 2019 data were not only complete and cleaner than the prior years, but they were also the most recent data with which to infer the current health behavior of the population. The sample, at 15,964 patients, was large enough for analysis.

Recommendations

For the future, I recommend researchers consider direct methods of collecting adherence data, such as observation and caregiver or family interviews, to get insights into direct medicine usage. This method would also allow researchers to have direct access to the patients to obtain data on underlying health beliefs and other socioeconomic

factors that affect adherence, complication development, and claims costs in the context of patients with medical aid coverage in Zimbabwe. This would assist in developing more nuanced approaches to behavioral interventions relevant to the study population. I also recommend analyzing adherence, complications, and claims ratio data as scale data so that their distribution can be determined and used to focus interventions and enable comparative analysis over time and populations.

Another point to note is that this was a cross-sectional study that focused on medicine adherence behavior in 2019 only. Running a longitudinal cohort study to observe how adherence behavior changes with the length of time on treatment would assist in focusing interventions to specific demographics according to their default propensity.

Implications for Professional Practice and Social Change

Recommendations for Professional Practice

This study demonstrated the relationship between adherence, complication development, and the cost of care. It also revealed worryingly low rates of medicine adherence in diabetes and HTN patients. Health care professionals need to be cognizant of these low rates and strive to educate their chronic patients on the need for adherence to long-term therapies. At all points of contact with chronic patients, all health care workers should assess and emphasize the importance of adherence for treatment effectiveness. For diabetics, such intervention should focus not only on medicine adherence but other factors important in diabetes control, such as diet and physical activity. Cimas Medical Aid Society has a pivotal role in their members' health education. As part of their client

engagement in their bid to inspire healthier communities, they have a good vantage point for effective communication. They can be involved in primary, secondary, and tertiary prevention. Primary prevention can be attained through the iGo wellness program, which seeks to encourage disease prevention through physical, mental, social, and other dimensions of wellness.

For secondary prevention, as observed in this study, I recommend that health care practitioners, as part of their treatment protocols, have specific patient adherence assessments and design interventions according to the default risk profile of the patient. Matzke et al. (2018), Messerli et al. (2016), and Pan et al. (2017) noted that pharmacists and physicians are especially well positioned to develop, along with caregivers, patient-centered adherence protocols. This study exposed the propensity of nonadherent patients for complication development and higher costs of care. This finding speaks to the need for support for debilitated patients by planning for high care claims through rehabilitation and support services. I recommend that the medical aid society ensures the availability and accessibility of such services for its members.

Potential Impact for Positive Social Change

The results of this study have far-reaching implications for social change regarding medicine adherence and cost of care. The growing incidence of chronic diseases and the resultant increasing cost of care is a cause for concern. Medicine adherence has been shown to be a significant factor in ensuring disease control complication development and the attendant cost of care. Health care workers must be more involved in working with their patients to ensure disease control. Primary

prevention is undoubtedly the most important in ensuring healthy communities, especially in low-income settings. This is achieved through effective community health education for all age groups. Secondary prevention, which was the focus of this study, hinges on communication at contact and ensuring post consultation adherence support.

The contribution of this study to social change at a personal level is that, as individuals understand the correlation between nonadherence, poorer health, and increased cost of care, they are likely to engage in behavior change that improves their outcomes and quality of life. When chronic diseases are controlled, patients can continue living normal to near normal productive lives without incurring avoidable care costs, whether self or state funded. At the family and community levels, knowledge of the impact of nonadherence helps family members and caregivers understand their importance in supporting chronic patients to comply with their treatment protocols, especially pharmacotherapy. The demonstrated results of improved outcomes and savings on health care costs bode well for health, wellness, and a fuller community life.

The social-economic impact of reduced wastage of medicines and better disease control, result in health savings that the National Association of Chain Drug Stores estimated at $300 billion annually (Boylan, 2017). This means that chronic patients with controlled disease can live normal or near normal lives as they have lower chances of complications, which results in savings for health care systems. The observed low rates in this medically insured population debunks the belief that cost of medicine is the major factor affecting adherence.

The implication of this study on Cimas Medical Society is that they are uniquely positioned to influence the health behavior of their members. By tracking health data for matrices, such as adherence behavior, complication development, and care costs, the Medical Aid Society can direct interventions at the most at-risk groups within their membership. Primary prevention should be targeted at all members of the society from early ages through wellness programs, such as their iGo program. Secondary prevention, which was the focus of this study, would be achieved through continual disease-specific education and adherence at every point of contact with health care workers at consultations at the clinics and pharmacies. Medicine delivery logistics can be enhanced through home delivery services to remove some of the non cost barriers to collection. The Cimas Managed Care department can track adherence behavior and complication development as well as craft personalized adherence plans for chronic disease patients.

Conclusion

Literature asserts that medicine adherence may be the single most critical determinant of good chronic disease outcomes, more important than medicine efficacy. In this study, I aimed to determine the extent of the association between medicine adherence, complication development, and cost of care in diabetic and hypertensive members of the Cimas Medical Aid Society, controlled for age and gender. The results revealed that medicine adherence strongly predicts complication development and hypertensive patients' adverse claims ratio. I found no relationship between adherence and complication development in diabetic patients, although an adverse claims ratio was associated with nonadherence. Therefore, I conclude that the cost of medicine is not the

only barrier to medicine adherence, and thus, health care workers and the Medical Aid Society have a pivotal role to play in ensuring that non cost barriers to medicine adherence are addressed.

As these barriers are addressed and adherence rates increase, the number of patients who develop complications should gradually decrease because the chronic diseases will be better controlled. Cost of care, represented by the claims ratio, would also decline because less specialist care and hospitalization for uncontrolled disease become necessary. The lower complication rate means that only costly primary health care for chronic disease care will be utilized, resulting in lower utilization of higher care levels, thereby reducing the cost of care per patient.

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