PATTERNS AND DETERMINANTS OF DYSLIPIDEMIAS AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS AT KENYATTA NATIONAL HOSPITAL

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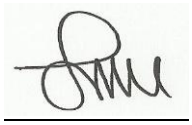
Signature  Date 28-11-2020

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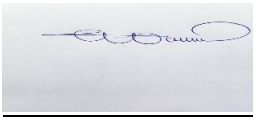
Signature  Date 28-11-2020

DEDICATION

I dedicate this work to my dear wife Evelyn for the encouragement and children Elysia and Elsie.

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ABSTRACT

Background: Dyslipidemia is markedly common in type 2 Diabetes Mellitus patients and one of the modifiable risk factors for cardiovascular disease, which is responsible for the increased burden of disease and mortality in diabetic patients. The use of lipid-lowering agents and lifestyle modification remains a fundamental approach in controlling diabetic dyslipidemia. However, suboptimal treatment of lipid abnormalities and underutilization of lipid-lowering agents in high-risk individuals, including patients with T2DM, remains a common challenge in clinical practice. There is inadequate information on the level of control of lipids profile and the determinants among patients with T2DM, especially in low and middle-income countries in Africa, including Kenya.

Broad Objective: The study aimed at evaluating the patterns and determinants of dyslipidemias among patients with type 2 Diabetes mellitus in a tertiary level facility in Kenya.

Methodology: A hospital-based cross-sectional survey was done. A total of 235 participants aged between 40-75 years old with T2DM were randomly selected. A researcher administered a questionnaire, and abstraction forms were used to collect the data. STATA Version 13 was used to analyze the data. Both descriptive and inferential statistics used to summarize the study results and deduce inferences between the dependent and explanatory variables. Bivariate and multivariate logistic regression models were applied to establish the association between the outcome variable and independent variables with the level of significance set at $p \leq 0.05$.

Results: A total of 235 T2DM participants were involved, of which the majority were female, 60.4%. The median age of participants was 60 (52-67) and hypertension was the prevalent comorbidity (60.9%). Statins were the only lipid-lowering agents prescribed 63.8%, with most participants prescribed moderate atorvastatin intensity (57.4%). Lifestyle modification strategies indicated for lipid modification included dietary change (69.2%), moderate physical exercise (58.5%), and control of social habits such as smoking and excessive alcohol intake. Isolated dyslipidemia with elevated LDL-c was the most prevalent dyslipidemia pattern followed combined elevated TG and LDL-c.

Adherent to lipid-lowering agents was observed in only 48% of the participants. The proportion of participants with optimal LDL-C control (<2.6 mmol/l, TG (<1.7 mmol/l), HDL >1.04 mmol/l(male) and >1.30 mmol/l(female) and non HDL-C < 3.37 mmol/L was 50.2%, 17%, 88.2% and 72.3%, respectively. Adherent to lipid lowering and the use of lipid-lowering agents (statins) was significantly associated with LDL-c target control (AOR 2.0; CI 1.16-3.47; p=0.013), and (aOR 2.2;CI 1.26-4.03 ;p=0.006). Predictors for optimal non-HDL-C control include; higher level education (aOR 2.2.;CI-1.00-4.87:p=0.04), lipid lowering agent use(aOR 2.0;CI 1.01-3.88:p=0.024) and hypertension (aOR 2.0;CI 1.04-3.67 : p=0.036).

Conclusion: The control of dyslipidemia among T2DM patients attending the outpatient clinic at KNH is still inadequate because of the underutilization of lipid-lowering agents and patients' non-adherence to lipid-lowering therapy.

Recommendations: The utilization of lipid-lowering drugs among T2DM patients should be enhanced. This can be achieved through sensitizing both the prescribers and patients.

ABBREVIATIONS AND ACRONYMS

ASCVD	Atherosclerotic Cardiovascular Disease
aOR	Adjusted Odds Ratio
CHD	Coronary Heart Disease
CKD	Chronic Kidney Disease
COR	Crude Odds Ratio
CPGs	Clinical Practice Guidelines
CVA	Cerebral Vascular Accidents
CVD	Cardiovascular Disease
HDL-C	High-Density Lipoprotein
HTN	Hypertension
KNH	Kenyatta National Hospital
LDL-C	Low-Density Lipoprotein cholesterol
LLD	Lipid-Lowering drugs
NCD	Non-Communicable Disease
non-HDL	Non-High-Density Lipoprotein
PAD	Peripheral Artery Disease
Sd LDL-c	Small dense Low-density Lipoprotein
T2DM	Type 2 Diabetes Mellitus
TC	Total Cholesterol
TG	Triglyceride
TLC	Therapeutic Lifestyle Changes

DEFINITION OF OPERATION TERMS

Atherosclerosis- refers to the thickening and loss of elasticity of the arterial wall because of atherosclerotic plaque formation within the arteries' intima. It is characterized by progressive narrowing and hardening of arteries due to intramural deposition of LDL and calcium secondary to smooth muscles' exposure to lipids.

Cardiovascular disease refers to the disease condition that causes damage to the heart or blood vessels and includes coronary artery disease, peripheral artery disease, Congestive heart disease, and stroke.

Dyslipidemia refers to an abnormality in the plasma lipoprotein concentration or compositions

High-density Lipoproteins: Complex molecules comprising of multiple proteins and lipid particles; this class of lipoprotein has relatively high density. Their purpose is to transport cholesterol from the tissue to the liver.

Hypertriglyceridemia is blood level of triglyceride level more than 150mg/dl or higher than 1.7mmol/L

Insulin resistance: A state of the reduced ability of cells to react to insulin action in carrying glucose from the bloodstream into muscle and other tissues. It usually develops with obesity and indicates the onset of type 2 Diabetes Mellitus

Low-density Lipoproteins are complex molecules comprising of multiple proteins and lipid particles that have a relatively low density. Their function is to transport cholesterol from the liver to the body tissues

Very Low-density lipoproteins are complex molecules made up of triglycerides, cholesterols, and proteins. Very low- density lipoprotein is synthesized by the liver and are mainly used to transport triglycerides in blood from the liver to body tissues

CHAPTER ONE: INTRODUCTION

1.1 Background

Type 2 Diabetes disease is associated with a 2 to 4-fold excess risk of death due to cardiovascular diseases and complications. Evidence from large prospective studies has attributed the rising burden of disease and mortalities in T2DM to coronary artery disease (CHD) (1–3).

Individuals with T2DM are more likely to develop major coronary artery events than non-diabetic individuals which is a result of the increased prevalence of lipids abnormalities in diabetic patients (4,5).

Dyslipidemia is markedly common in T2DM and is a consequence of insulin resistance or deficiency which is characteristic of diabetes disease. Additionally, lifestyle factors such as unhealthy eating habits and physical inactiveness have also been associated with rising cases of dyslipidemia (4).

A typical lipid abnormality pattern in T2DM comprises a high level of triglycerides (TG), low high-density lipoprotein cholesterol level (HDL-C), and a preponderance of small dense LDL-C particles, which together are highly atherogenic (4,6,7).

In people with T2DM, dyslipidemia correlates well with macrovascular events, while hyperglycemia has primarily been associated with increased microvascular complications (8,9). Thus, aggressive assessment and management of hyperglycemia alongside other potentially modifiable risk factors in T2DM can significantly reduce cardiovascular risks.

Numerous strategies have been tried for many years to reduce cardiovascular risks, including strict glycemic control and lipid levels control, While tight glycemic control has proven important in controlling microvascular events, clinical trials have failed to prove its effectiveness in preventing macrovascular events (10). Lipids level control remains the most reliable strategy in reducing cardiovascular risks in diabetes (10).

In many guidelines, lowering of the LDL-C level remains the main target in controlling diabetic dyslipidemia (11). Non-HDL-C lowering may be considered a secondary target after attaining the optimal LDL-C levels. Clinical studies have demonstrated the

importance of lifestyle modification in the control of lipid abnormalities. Furthermore, the use of lipid-lowering agents in diabetes is effective in reducing cardiovascular risk (12).

The Statins have shown superior efficacy and safety in reducing cardiovascular risk such that lowering LDL-C level by 1 mmol can reduce major cardiovascular events by 21% (11,13), which has made it adopted in many clinical practice guidelines as the first choice pharmacological agents for dyslipidemia control.

Non-statin agents, including bile acid sequestrants, ezetimibe, fibrotic acid, and nicotinic acid, have often been considered alternative therapies in the presence of statin intolerance or as adjunctive therapy if a single agent is insufficient to achieve the recommended lipid targets. Niacin or fibrates have shown significant benefits in situations where triglyceride and HDL levels remain uncontrolled with statin therapy; however, their use in diabetic patients is limited due to their impact on glycemic levels (10).

1.2 Problem Statement

Individuals with T2DM experience a greater risk of developing cardiovascular diseases than those without. Among the established cardiovascular risk factors in T2DM, dyslipidemia remains the leading cause of cardiovascular disease.

Dyslipidemia is markedly common in T2DM and is an independent risk factor for atherosclerotic cardiovascular disease, which is responsible for the high morbidity and mortality cases among the T2DM. Diabetic patients with established cardiovascular diseases and complications suffer a greater burden of the disease unlike those with diabetes alone (4,14).

Tight glycemic control remains the primary target in diabetic management, however, adequate control of cardiovascular risk in T2DM require the control of other potentially modifiable risk factors (15,16). In one metalysis, each one mmol lowering of LDL-C was shown to reduced stroke and major coronary events by one fifth which signify dyslipidemia as an important modifiable cardiovascular risk factor.

Many Clinical practice guidelines have strongly recommended lowering lipids in diabetic patients to target levels to control cardiovascular risk. Moreover, compelling evidence have demonstrated the positive benefit of using lipid-lowering agents and lifestyle modification

measures in improving cardiovascular outcomes. However, despite this, numerous studies have reported suboptimal control of lipid levels (17) and underutilization of lipid-lowering therapy(7,18–21). Furthermore, the lack of treatment intensification based on lipid levels (17) and non-adherence to lipid-lowering therapy remains a challenge in clinical practice (22,23). Failure to identified and addressed such challenges may negatively impact the quality of care for diabetic patients. Optimal control of cardiovascular risk in T2DM depends on the quality of both pharmacological and non-pharmacological care provide to patients. In sub-Saharan Africa, the information on the management of dyslipidemia among T2DM patients is scarce. This study, therefore, sought to determine the pattern and determinants of dyslipidemias among patients with T2DM at Kenyatta National Hospital, a tertiary level facility.

1.3 Purpose of the Study

This study focused on evaluating the management of dyslipidemia among type 2 diabetic patients attending the Diabetic and Endocrinology clinic at KNH with a view of determining the predictors for lipid level control. The understanding of factors that influence lipid control will help improve dyslipidemia management, and ultimately reduce cardiovascular risk.

1.4 Objectives

1.4.1 Main Objective

The primary study objective was to evaluate dyslipidemia management and associated factors among type 2 Diabetes Mellitus patients at Kenyatta National Hospital.

1.4.2 Specific Objectives

The specific objectives of the study were:

I. Establish the type of Lipid-lowering agents and nonpharmacological approaches used to manage dyslipidemia in type 2 diabetes mellitus at KNH
II. Determine the level of patient adherence to lipid-lowering therapy
III. To determine the pattern of lipid profiles among patients with T2DM at KNH
IV. Identify the correlates of adequate control of lipid levels among T2DM patients.

1.5 Research Questions

I. What types of lipid-lowering agents and non-pharmacological approaches indicated in patients with Type 2 Diabetes Mellitus at KNH for managing dyslipidemias?
II. What is the level of patient adherence to lipid-lowering therapy?
III. What are the patterns of lipid profiles present among patients with Type 2 Diabetes Mellitus at KNH?
IV. What are the correlates of lipid level control among T2DM patients?

1.6 Justification of the study

Dyslipidemia is a common comorbidity in T2DM and a significant risk factor for atherosclerotic cardiovascular disease. More than 80% of deaths in T2DM patients are attributable to cardiovascular disease (7), representing an estimated global mortalities of 63% (24).

The main aim of managing T2DM is to prevent and delay cardiovascular disease and events. Since the development of atherosclerotic cardiovascular diseases in diabetes is multifactorial, the management of diabetes should focus on all the potential risk factors, including dyslipidemia.

Evidence has shown improved cardiovascular outcomes in T2DM patients by lowering LDL-cholesterol levels. However, numerous studies in resource endowed settings report suboptimal control of lipid abnormalities in the high cardiovascular risk population. Additionally, many individuals with T2DM are neither on lipid management nor attain the recommended target lipids level whenever they are managed with lipid-lowering drugs.

In developing countries in sub-Saharan Africa, many studies in T2DM patients have mainly focused on establishing the prevalence of dyslipidemias and associated risk factors; little remains known about the pattern and determinants of dyslipidemia in this patient cohort. Knowledge of this is essential in ensuring adequate control of cardiovascular risks in T2DM patients. This study sought to determine the patterns and determinants of dyslipidemia and associated factors among patients with T2DM attending the Diabetic and Endocrinology clinic of KNH.

This survey will provide more information on the level of control of lipid abnormalities in these patients and help identify the management practices gap. The data from the study will also add to the existing database for future and more extensive studies. This study's recommendation may form a framework for further policy formulation at the Ministry of Health and the change in treatment protocols focusing on optimizing lipid-lowering therapy and improving cardiovascular outcomes in this patient group.

1.7 Delimitation

The survey was conducted at the outpatient diabetic clinics of Kenyatta National Hospital in Nairobi and involved only adult patients diagnosed with type 2 Diabetes Mellitus aged between 40-75 years old, receiving care at the clinics. The study findings, therefore, are limited to this patient population.

1.8 Conceptual framework for determinants of adequate lipid control in T2DM

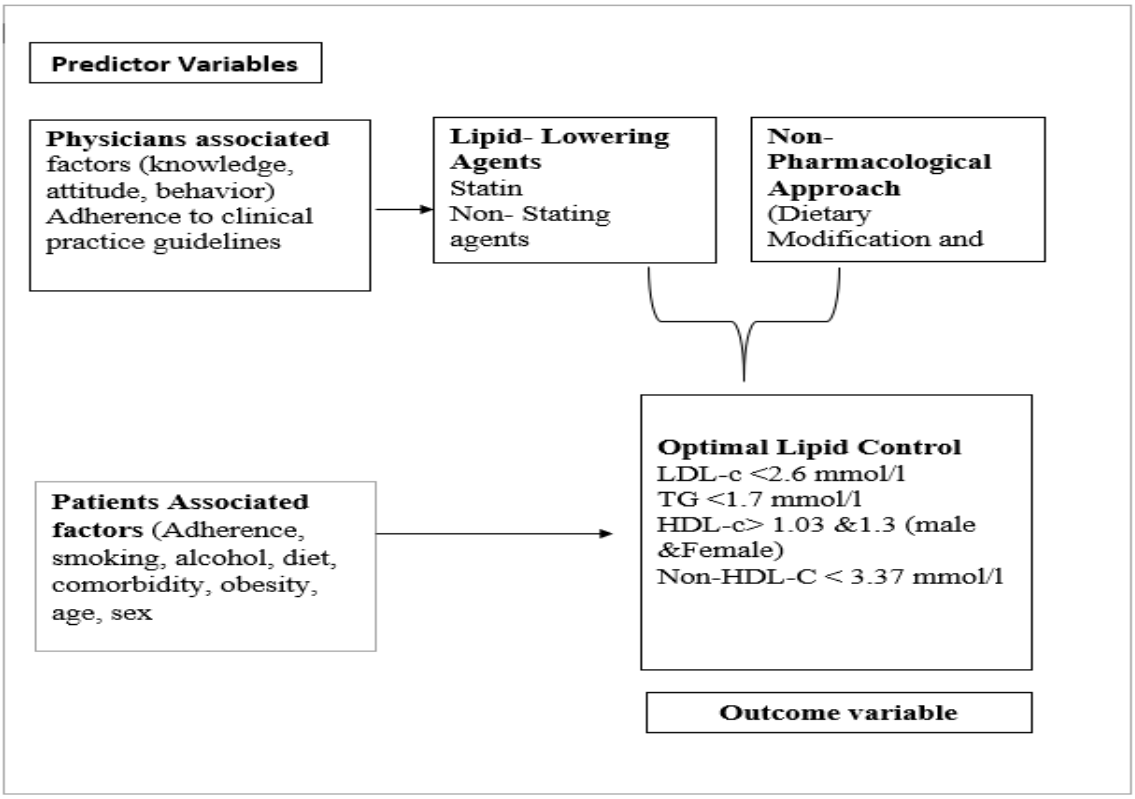

Figure 1. Conceptual framework; Authored by katayi 2020

Optimal Lipid levels control was the primary outcome variable of this study. According to American Diabetes Association (ADA) guideline, dyslipidemia treatment in diabetic

patients should be to target LDL-C level of below 2.56 mmol/L, Triglyceride level of 1.7mmol/L, and high-density lipoprotein level of 1.04 mmol/L in male and 1.30mmol/l in women (25).

Non-pharmacological management, which comprises: dietary modification, weight loss (if indicated), and physical exercise, remains a fundamental approach in both initial treatment and control of dyslipidemia in a patient with T2DM(7). Statins are considered the first choice lipid-lowering agents for treatments and control of dyslipidemia in T2DM (7). Non-statin therapy such as cholesterol inhibitor(Ezetimibe) may be combined with statins when rapid achievement of target LDL-C level is needed or in a patient intolerance to the recommended statin dose (7).

Effective management and control of dyslipidemia in T2DM depend on several factors which may either be physician-related or patient-related. Physician knowledge, attitude, and behaviors (26) may influence the lipid-lowering agent prescribing pattern and Adherence to the recommendations' clinical practice guidelines. Suboptimal Adherence to clinical practice guidelines could manifest as inaccurate dosing and inappropriate selection of lipid-lowering agents (26).

Patient-related factors such as failure to compile to lipid-lowering therapy may also contribute to the lack of therapeutic LDL-C goal attainment. Other patient-related factors that could influence treatment outcomes include social habits such as smoking, excessive alcohol intake, physical inactiveness, unhealthy eating habits, obesity, comorbidities, and other medications. Patient's age, gender are some of the non-modifiable risk factors with a possible effect on lipid levels. (26) (**Figure 1).**

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter evaluates the existing literature that focuses on the study's main variables to appreciate other scholars' findings and ideas about the study topic. Literature that focuses on dyslipidemia management in diabetes, Adherence to lipid-lowering therapy were reviewed.

2.2 Dyslipidemia in Type 2 Diabetes Mellitus

Non-communicable diseases (NCDs) are, by far, the leading causes of death globally. Diabetes mellitus, together with cardiovascular diseases, are the significant contributors to the rising NCD associated mortality cases in the world (27). Diabetes Mellitus in sub-Saharan Africa is on the rise, with an estimated 40.7 million people expected to have the disease by 2045, up from 15.9 million people in 2017 (28).T2DM is the most prevalent among all types of diabetes, accounting for more than 90% of global diabetes cases (29). Additionally, it is the leading cause of death in the adult population due to cardiovascular complications.

Dyslipidemia is an established cardiovascular risk factor and common complication in T2DM, with a prevalence of as high as 70% (30). The lipid abnormalities prevalent in T2DM may involve qualitative, quantitative changes, or both, resulting in a shift to the atherogenic profile (30). The quantitative abnormalities include elevation of triglycerides levels and reduced HDL-C concentration. Simultaneously, qualitative changes involve the increase of small dense low-density lipoprotein particles (SdLDLp) and VLDL, a precursor for SdLDLp (7,30).

Hypertriglyceridemia is characteristic of diabetic dyslipidemia and may result from overproduction or decreased clearance. Insulin resistance (I.R.), which occurs in T2DM patients, may elevate triglyceride levels by increasing VLDL1 concentration and triglyceride particles (30). Elevated T.G level indirectly reduces HDL-C level by increasing the cholesterol ester transfer protein (CETP), leading to triglyceride transfer to HDL and LDL from triglyceride-rich lipoprotein.

The sd-LDLp are more susceptible to modification through glycation and oxidation, making them highly atherogenic components. Furthermore, they can easily cross the arterial intima and are less bound to the LDL-C receptor. Although LDL-C levels in a patient with T2DM may occasionally be within normal ranges or comparable to that of non-diabetic patients, the LDL-C particles show reduced turnover, which is highly atherogenic (30).

2.3 Lipid profile in T2DM and associated cardiovascular risks

Dyslipidemia in T2DM manifests as elevated triglyceride, low HDL-C levels, and elevated sd-LDL variants of the low-density lipoprotein cholesterol (LDL-C). Evidence from epidemiological studies has demonstrated a relationship between raised plasma triglyceride levels and coronary artery disease (CAD) (7). Furthermore, genetic studies have established a causal relationship between elevated triglyceride lipoprotein levels and cardiovascular disease (31).

Previous epidemiological studies have demonstrated a positive association between low HDL-C and increased CVD risks (32,33). Overwhelming evidence from epidemiological, genetics, animal studies, and clinical trials has documented an association between LDL-C and CVD. Patients with T2DM may have normal or slightly elevated LDL-C. Even so, raised small dense lipoprotein particles (sd-LDL-C) levels are predominant, which are considered highly atherogenic than large LDL particles (7,34). Furthermore, studies have attributed sd-LDL-C to cause the residual cardiovascular risks that persist even after attaining LDL-C therapeutic goals in a patient with T2DM (35).

2.4 Clinical practice guidelines recommendations

Many clinical practice guidelines on management and control of dyslipidemias exhibit more similarities in their recommendation than differences. Bartlomiejczyk *et al*., in their review of clinical guidelines, pointed out the need to have a universal solution to clinical practice guidelines to help in the standard management of dyslipidemia (36).

Most CPGs, including the Kenyan National guidelines for cardiovascular management, has strongly emphasized statins as the first-line pharmacological agent in controlling atherosclerosis and cardiovascular events (36,37). Another similarity in the CPGs categorizes statins by their efficacy in low, medium, and high-intensity classes (**Table 1**).

Table 1. Summary Statin dosing range and intensity

High-Intensity (≥ 50%)	Moderate intensity (30-49%)	Low Intensity (< 30%)
Atorvastatin 40- 80 mg Rosuvastatin 20-40mg	Atorvastatin 10 (20 mg) Rosuvastatin (5) 10 mg Simvastatin 20-40 mg (80 mg)	Simvastatin-10 mg
	Pravastatin 40 mg (80 mg) Lovastatin 40 mg (80 mg) Fluvastatin 40 mg BID	Pravastatin (10-20 mg) Lovastatin- 20 mg Fluvastatin 20-40mg

2.5 Lipid-Lowering Agents in T2DM

Lipid-lowering therapy should be indicated based on the individual risk of developing CVD. The American College of Cardiology (ACC) and American Heart Association (AHA) guideline, which is adopted by the Kenya guideline for the management of cardiovascular diseases 2018 (37), recommends that patients aged between 40-75 years old with diabetes mellitus and LDL-C ≥2.6 mmol/L (≥100 mg/dL) should be started on moderate-intensity statins without calculating 10-year ASCVD risk. High-intensity statins to reduce the LDL-C level by ≥50% may be used in case of several risk factors or those 50 to 75 years of age (7).

The main aim of managing dyslipidemia in T2DM is to delay and prevent diabetic-related major cardiovascular events and complications (38). Evidence from a meta-analysis on the cardiovascular protective effect of statin that included a total of 18,686 patients demonstrated a 9% relative reduction in all causes of mortality and 21% reduction in major cardiovascular events(MACE) per mmol/L reduction in LDL-C (39,40), which explains the superior efficacy of statin therapy in lowering LDL-C.

Statins produce their effect by reducing the biosynthesis of cholesterol in the liver where they are highly distributed. By inhibiting the HMG-COA reductase enzyme, statins can modulate lipid production and metabolism. Statins can also indirectly inhibit the atherosclerosis process through the effect of its mevalonate metabolites, isoprenoids which are essential for cellular growth and differentiation (41).

Although the incidence of statin-associated side effects is likely to increase with a high dose, however, according to Bhatia and Byrne (2010), the benefit of statin therapy far much outweigh the adverse effects, mainly when used in moderate to high-cardiovascular risk patients (42). One study has revealed that early initiation of primary prevention with statin therapy may prolong CVD protection (43). However, the use of statin in pre-diabetic patients may conifer modest cardiovascular risk-protection (44).

In the face of unachieved or suboptimal LDL-C levels in T2DM, the option of adjusting the dose should be considered first before adopting a combination therapy. In one randomized control trial, adding ezetimibe, a cholesterol inhibitor (45), or nicotinic acid to statin therapy did not result in a considerable benefit of reducing CV risks (46). However, combination therapy can be considered in case of statin intolerance, safety, or when unable to attain the LDL-C even with maximum tolerable statin dose. **Figure 2.** summarizes the general approaches in managing the various type of dyslipidemia.

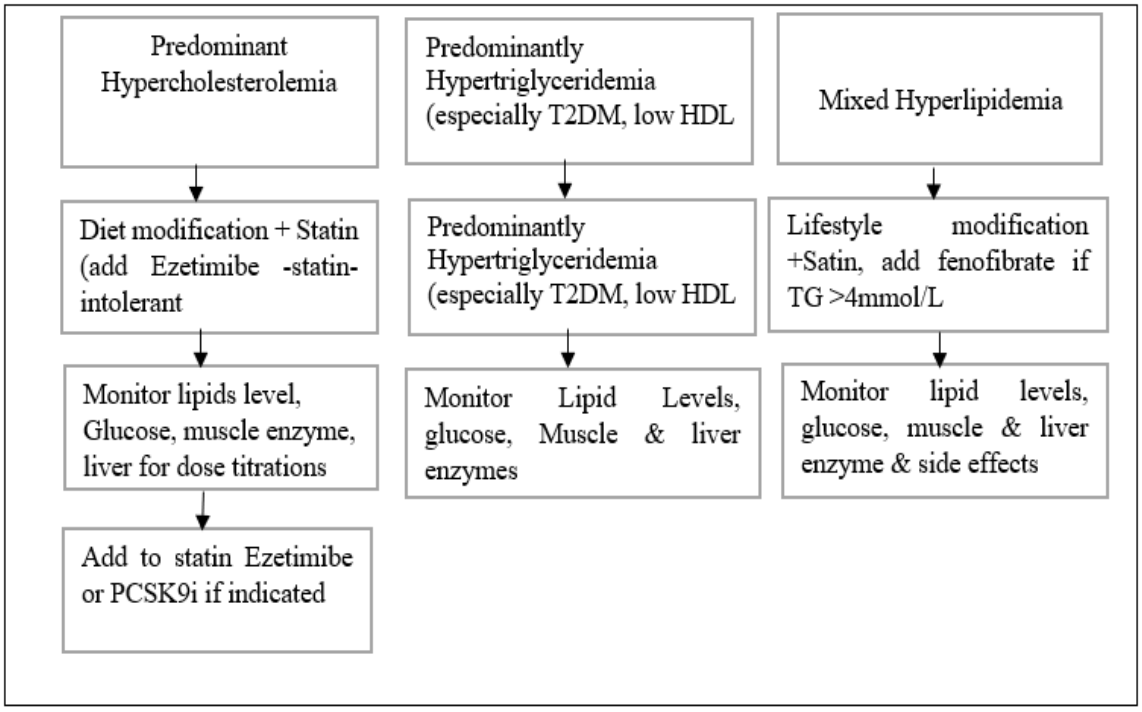

Figure 2. General approaches in the management of Dyslipidemias

Adapted from An updated review of lipid-lowering therapy (47)

2.6 Non-Pharmacological approaches

The non-pharmacological strategies recommended for managing and controlling dyslipidemia in T2DM include dietary modification, physical exercise, weight reduction (7), smoking cessation, and moderation of alcohol consumption. Patients with T2DM and metabolic syndrome are recommended to adopt a healthy lifestyle since it is demonstrated to significantly reduce hyperlipidemia, hyperglycemia, hypertension, and obesity (48).

Dietary modification including reduced intake of saturated fat, and trans-fatty acid; increased use of LDL-C lowering micronutrients such as plant stanols/sterols and viscous fibers, n-3 fatty acids are recommended in T2DM to improve the lipid profile (40). The American Dietary Association (ADA) guideline recommends the individualization of nutritional therapy when managing dyslipidemia in patients with diabetes (49).

One systematic review and meta-analysis that assessed the impact of different diets on lipid profile, glycemic level, and weight loss revealed a significant effect on HDL-C level with low carbohydrate diet and Mediterranean diets. In contrast, a high protein diet had no significant impact on lipid levels (50). However, the studies included in the systemic review and meta-analysis had extensive heterogeneity and involved different methodologies.

Physical exercise has been shown to reduce very-low-density lipoprotein Cholesterol (VLDL-C) and elevate HDL-C with a variable decrease in LDL-C. Moderate intensity physical exercises of at least 30 minutes, including brisk walking, water aerobics, and riding a stationary bike, are recommended in T2DM.

Smoking in diabetes mellitus patients has been associated with impairment in cardiometabolic parameters (51,52). In one community-based cohort study by Clair *et al.* that involved mostly non-diabetic patients, smoking cessation was associated with an increased HDL-C level of up to 5 %. Though this led to an increase in weight and had no effect on other lipids, a net improvement in cardiovascular outcome was observed (53).

2.7 Adherence to treatment guidelines.

Statins are the cornerstone in the management of diabetic dyslipidemia. Clinical practice guidelines offer a guide to clinicians and the health care team by promoting standard

decisions about the treatment; however, in real practice, the Adherence to clinical guidelines recommendation is suboptimal (54).

A study by Langner *et al*. on practices and attitude of primary physicians in the management of hypercholesterolemia revealed that, although physicians do give dietary counseling before starting statin therapy, drug treatment is begun at relatively high levels of serum cholesterol and with drugs that may be prescribed inappropriately, thus implying suboptimal Adherence to treatment guidelines. However, this practice differs from one setting to another (55).

Surveys conducted in Netherland, Scotland, and Malaysia, reported a relatively higher prevalence of lipid-lowering therapy prescription, i.e., 68%, 68%, and 87.6, respectively, while a study in Ethiopia had a relatively lower prescription rate of 55.7%. However, in the Netherlands and Scotland studies, the LDL-C target goal's achievement was reported in less than half of all patients on statin therapy. A study in Ethiopia reported a higher LDL-C goal attainment rate than that reported in the Malaysia study, i.e., 60.6% and 37%, respectively. Thus this signifies suboptimal utilization of statin therapy and non-adherence to the clinical practice guidelines (56–59).

Most literature reviewed included studies conducted in a primary care setting. It can be assumed that the situation might be different when a similar survey is done at a higher-level health facility. Moreover, Rand *et* al. observed that determinants such as knowledge, attitude, and behavior affect the prescriber's ability and Adherence to guidelines. He further pointed out that these determinants vary from one setting to another, and therefore a universal solution can not be applied to address the problem (60).

2.8 Patient adherence to Lipid-lowering drugs

Non-adherence to lipid-lowering therapy is one of the main obstacles to the effective control of lipid abnormalities (61). Lack of Adherence to statin treatment is associated with an enhanced risk of myocardial infarction (MI) and cardiovascular death (62).

Studies have revealed that a considerable proportion of patients on chronic medications stop taking statins in less than one year of starting (62). One of the main reasons for non-adherence to statin treatment is the associated adverse effects such as myalgia (62).

However, a study by Casula *et al.* observed that patient medication adherence is contributed by many other factors attributable to the physician or the patient (63).

Patient attitude towards the medicine, frustration with inadequate therapeutic response, poor understanding of the cost-benefit associated with the treatment, and insufficient knowledge of the treatment benefit are factors that can affect patient Adherence (63). A study by Yudin *et al.* reported a low rate of non-adherence to statin treatment among high-risk patients (1.7%). However, in the same survey, less than 37.7% of the participant had attained LDL-C targets, which might imply no significant association between Adherence and attainment of optimal LDL levels (61).

Two surveys done in a primary care setting revealed a high rate of non-adherence to lipid-lowering agents compared to the previous study by Yudin *et al.* The adherence rate to lipid-lowering agents in these studies ranged between 37% and 51 %. However, heterogeneity of the adherence tools applied and differences in a study setting may explain this huge disparity (61,64,65).

2.9 Literature gap

Many local studies in T2DM patients have focused on determining the prevalence of dyslipidemia. Data on the pattern and determinant of dyslipidemia among patients with T2DM and, more particularly, in a tertiary health care setting is limited. Moreover, little is known about the various type of lipid-lowering agents commonly indicated for patients with T2DM and the level of patients andherence to therapy. Therefore, this study aimed to bridge this gap by evaluating dyslipidemia control and associated factors among patients with T2DM attending the outpatient clinic at Kenyatta National Hospital.

CHAPTER THREE: MATERIAL AND METHODS

3.1 Introduction

This chapter outlines the various aspects of the methodology that was used to achieve the study objectives. It includes details on the research design, study site, target population, eligibility criteria, and sample size, sampling technique, data collection technique, data management analysis, logistical and ethical considerations of the study.

3.2 Research Design

The study was a hospital-based cross-sectional study. The design is an observational study applicable when it is desirable to determine the exposure and the outcome for each subject simultaneously. Furthermore, it is cost-effective and can efficiently describe the prevalence of exposure or outcome; hence, making it appropriate for the present study.

3.3 Study area and Site

The Study site was the diabetic and Endocrinology clinic of Kenyatta National Hospital (KNH). KNH is the largest and oldest referral Hospital in Kenya, founded in 1901 and has over 2000 bed capacity. It is located along Hospital Road, Upper Hill, Nairobi, and is the largest referral hospital in East and Central Africa. The facility is a teaching hospital that houses the University of Nairobi-College of Health sciences (UoN-CHS) and offers a learning environment for the Kenya Medical Training College. The hospital serves approximately 70,000 inpatients and 550,000 outpatients annually and has 50 wards, 22 outpatient clinics, 24 specialized theatres, and an Accident & Emergency department.

The Diabetic and Endocrinology clinic is located approximately half a kilometer from the main hospital block next to the Government Chemist. The clinic is the main entry point for all patients with diabetes and endocrinology conditions. Once the diagnosis of diabetes has been made, patients are enrolled in the clinic and put on appropriate therapy. Patients are given monthly or three-monthly appointments for follow-up management at the clinic, depending on their disease condition. The main-diabetic clinic is held every Friday of the week, while the mini- diabetic clinics are held on Monday and Tuesday every week. The health care team manning the clinic includes a consultant endocrinologist who is the lead person, and under her are the general physicians, doctors, pharmacist nurses, and nutritionist with additional training on the management of diabetes.

3.4 Target Population

The study's target population included adult patients with T2DM attending the outpatient diabetic clinic for KNH with a regular follow for at least three months since the time of diagnosis. Patients, less than 40 years of age with T2DM are considered to have lower 10-year cardiovascular risks. Moreover, little evidence from clinical trials exists that demonstrates the benefit of lipid-lowering agents in this patient population(66).

3.4 Eligibility Criteria

3.4.1 Inclusion Criteria

The inclusion criteria included:

I. Patients with a confirmed diagnosis of T2DM, aged between 40-75 years with a regular follow-up of 3 months or more.
II. Under 40 years, patients with T2DM and ASCVD with a history of diabetes for more than 10 Years.
III. All Participants consenting to participate in the study.

3.4.2 Exclusion Criteria

The study excluded

I. Patients with T2DM of less than 40 years with no ASVD (these patients have lower risks for cardiovascular events, and little clinical evidence exist that support the use of lipid-lowering agents)
II. Patients who are mentally ill (these patients are mentally challenged and cannot give informed consent)
III. Patients who are pregnant (lipid-lowering agents are contraindicated).

3.5 Sampling

In this study, the primary outcome was the attainment of optimal lipid levels among the study participants. The lipid levels were categorized as on the target level or not on the target level. Several studies on the treatment of dyslipidemia in diabetic and non-diabetic populations have reported the proportion of attaining target lipid levels, ranging between 20 to 80.2% (15,58,61). One similar study conducted locally in a County Hospital in Kenya reported a 22.9% attainment of target lipid levels among T2DM patients (67).

Since the primary outcome variable involved in the study was categorical, the Choncran (1977) formula was applied to calculate the sample size as follows:

$$n_0 = \frac{Z^2 \times \mathrm{P}(1-\mathrm{P})}{d^2}$$

Where: n = the calculated study sample size

P is the prevalence of attainment of target Lipid levels in T2DM patients (22.9%) as per a study local study done in a county Hospital in Kenya (67).

Z is the standard normal deviate (1.96) at a 95% Confidence interval (CI) when the population is >120.

d- the set level of precision for the study (0.05), a general margin of error used in most scientific research. n_o

Substitution of the values in the Formula:

$$n_0 = \frac{1.96^2 \times 0.229(1-0.229)}{0.05^2}$$

n_0 =271 participants,

However, this number applies if the target population size is at least 10,000. According to the records at KNH, the number of diabetic patients who attend the clinics is approximately 480 per month. The data collection period was three months based on the time allowable according to the course structure. Therefore, the target population was approximately 480 x 3= 1140

Using the reduction formula

$$n = \frac{n0}{1+ n0/N}$$

Where:

n = Minimum sample size required

n_0 = calculated sample size (271 Patients)

N = Total number of patients who attended the clinic over three months period

n= 271/ (1+ 271/1140) = 218

Sample size adjustment by 10% to cater for non-respondent, giving a sample size of 240 participants.

3.6 Sampling Technique

A simple random sampling technique was used to select the participants, which allowed an equal chance for all participants who meet the inclusion criteria to be included in the study. Medical files for the patients booked to attend the clinic were obtained from the health records office a day before the clinic day. The principal investigator (PI) on the morning of the clinic day reviewed the file in advance to identify patients who meet the inclusion criteria using the eligibility screening form (Appendix 3). The sampling frame included all the outpatient files for patients that meet the inclusion criteria on every clinic day. The sampling frame files were assigned a unique tag to allow for quick identification and distinguish them from the other files retrieved for the patients booked on the material clinic day. The principal investigator flipped a coin, and the file that scores the head was selected, and the owner was considered for inclusion into the study.

On the clinic day, the nurse on duty could randomly guide the patient to the clinician's office after recording the patient's weight and height in the medical file. The clinician was requested to direct all patients whose files have been tagged to the PI after attending to them.

The potential participants were taken through the informed consent process, and only those who agreed to participate and sign the declaration form were included in the study. This process was repeated on every clinic day until the attainment of the desired sample size of 240 participants.

In the diabetic and Endocrinology clinic, patients who attend the minor clinic are usually given monthly appointments, while those who attend the major review are given quarterly or semi-annual appointments. A different tag was used each month to avoid sampling the same patient twice.

3.7 Participants Recruitment Process

Participants' recruitment happened during the patient's regular follow-up clinics. The clinician on duty was requested to direct the patient with a tagged file to the principal investigator. This was done randomly as the patients come to the clinic.

The principal investigator could engage the participant by giving them information about the study. A coin was tossed to decide the participant for consenting and possible inclusion in the study. Only those patients who achieve the 'Heads' after flipping the coin were considered for consenting and possible recruitment. The participant who agrees to participate in the study was guided through the informed consent process in the language applicable to them (English version Appendix 5a or Kiswahili version Appendix 5b), after which they were required to sign the consent declaration (Appendix 4). By signing the consent, a participant was deemed recruited to the study. A questionnaire (Appendix 6) was then be administered to gather the necessary social demographic and clinical information. This process was repeated on every clinic day until the required sample size is achieved.

3.8 Research Instruments

3.8.1 Eligibility Screening Form

The Eligibility form was used to guide in the selection of individuals who meet the inclusion criteria (Appendix 3)

3.8.2 Informed consent form and consent declaration form

An informed consent form (Appendix 5a or 5b) involves information about the study. This form was used to notify the eligible participants about the study and what was expected of them. The selected participants who are willing to participate in the survey were required to sign a consent declaration form (Appendix 4) before they are enrolled in the study. The Consent form and the declaration form was in two versions, English, and Kiswahili language

3.8.3 Data Collection sheet/form

The data collection form (Appendix 7) was used to abstract secondary data from the patient files. This includes the patient's social demographic information, patient medication

history, patient baseline, current lipid parameters, and any other relevant information needed to achieve the study objectives.

3.8.4 Pre-testing

The research instruments, including the questionnaire and the data collection forms, were pre-tested on a few participants before collecting data. The pilot study helped test the questionnaire's validity and assess relevant information such as the approximate time required to administer the instrument and collect data from an individual patient.

3.8.5 Validity

The research instruments, which include the questionnaire and data abstraction form, were designed to ensure that all the desired information to answer the research question was captured.

3.8.6 Reliability

A pre-test of the questionnaire and data collection tool was done using 10% of the enrolled participants. The pilot study's findings helped in estimating the time it will take to conduct an interview and highlight issues in the questionnaire, if any, that need to be an adjustment.

3.8.7 Data Collection Techniques

Data collection commenced after the eligible participants have provided written informed consent. The process was in two phases; the first phase involved patient interviews using a structured questionnaire and then abstracting relevant information from the participant's medical records and treatment charts. The questionnaire was designed to capture patient information on social demographic data, lipid parameters, comorbidities, and co-prescription medications. Information on patient adherence to treatment was also assessed using the Morisky-8 tool.

The second phase involved data abstraction by careful examination of patient medical files and treatment charts. Data to be collected included laboratory parameters including baseline and current lipid panel (less than a one-year reading of Serum LDL-C, HDL, and Triglyceride level). Patient history of lipid-lowering therapy (LLT) use, modification of treatment, and the current prescribed LLT, including information on the dose, was also extracted from patients' files.

The forms, together with the questionnaire, were filed and kept under lock and key to limit access and ensure patient confidentiality.

3.9 Data Management

3.9.1 Data Acquisition

Standard data collection tool involving questionnaire and Data collection form developed was piloted and modified before use. The principal investigator conducted the data collection. The data was coded, cleaned, and validated before entering it into a predesigned excel spreadsheet. The data were checked for consistency, completeness, and accuracy before and after inputting into the database (the excel spreadsheet). Missing data was also be indicated in the data collection form. The database was password-protected to allow single access.

3.9.2 Data analysis plan

STATA Version 13 was used to analyze the data. Both descriptive and inferential statistics were used to summarize the data. Categorical variables, such as gender, marital status, level of education, comorbidities, lifestyle modification strategies, type of medications, and patient adherence level, among others, were summarized in frequencies and proportions. Measures of central tendency were used to summarize continuous data such as age. The results were presented in tables and charts.

Tests for normality, homoscedasticity, and homogeneity were done on all the variables. The variables which pass the test were subjected to inferential analysis. Chi-square and Fischer's exact was used to assess the association between the status of the outcome variables (lipid level) and explanatory variables. The association's magnitude was determined using logistic regression with the lipid profile state as a dependent variable. The level of significance was set at $p \leq 0.05$. A dummy presentation of results is shown in appendix 6.

3.9 Study variables

The primary outcome variable for the study was the attainment of the target LDL-C level. The main predictor variable of the study is the lipid-lowering therapy. Other factors that could influence the outcome variable include patient-related factors such as Adherence to lipid-lowering therapy, intensity statins used, comorbidities, and social habits such as

smoking and alcohol intake. Patients' age and gender, among others, are the possible confounding variables.

3.10 Ethical considerations

3.10.1Ethical approval

Ethical approval was sought from the Kenyatta National Hospital and The University of Nairobi Ethical and Research Committee (KNH/UON-ERC) Appendix-1. Permission was sought from the KNH Research department and Medicine department to access patients' medical records (Appendix 2)

3.10.2 Informed consent process.

All the participants eligible for the study were taken through the consent form (Appendix 5a or 5b), and once they are familiar with the details of the study and agree to participate in it, they were provided with a consent declaration form (Appendix 4) to sign.

3.10.3 Confidentiality

The study used serial numbers instead of patients' names during the data analysis process to safeguard the participants' identity. All the forms used to collect data from the participants were kept under lock and key by the principal investigator during the entire study.

3.10.4 Risks involved

The study involved only the collection of the blood sample from eligible participants for testing the lipid profile. This is a standard routine procedure that the participants are subjected to during their routine visits at the clinic. It is believed that the participant did not suffer any significant risk other than the small discomfort experienced after the drawing of the blood sample.

3.10.5 Benefits of the study

The participants were guided through their treatment and reminded of the importance of adhering to the treatment plan. Any concerns raised by the participants during the interaction with the Principal investigators were the channel to the department's nursing officer-in-charge.

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CHAPTER FOUR: RESULTS

4.1 Introduction

The results of the study are presented in this chapter. The findings are summarized using descriptive and inferential statistics and presents in frequency tables, pie charts, and bar graphs.

4.2 Sociodemographic and clinical characteristics

Table 2. Social demographic and Clinical characteristics

Age (Years)	Category	Frequency (n=235)	Percentage (%)
Gender	Male	93	39.6
	Female	142	60.4
Age (Years)	≤40	3	1.3
	41-50	45	19.1
	51-60	79	33.6
	61-70	73	31.1
	>70	35	14.9
	Median age 60 IQR (52-67) years		
Marital status	Single	18	7.7
	Married	182	77.4
	Widowed	30	12.8
	Divorced/Separated	5	2.1
Education	Informal	19	8.1
	Primary	64	27.2
	Secondary	93	39.6
	Tertiary	59	25.1
Employment	Employed	37	15.7
	Self-employed	84	35.7
	Unemployed	66	28.1
	Retired	48	20.4
BMI	<18.5	3	1.3
	18.5-24.9	60	25.5
	25.0-29.9	120	51.1
	>30	52	22.1
Duration of diabetes (years)	<1	14	6.0
	1 – 5	69	29.4
	6 – 10	54	23.0
	11 – 15	38	16.2
	16 – 20	31	13.2
	21 – 25	19	8.1
	26 – 30	7	3.0
	>30	3	1.3
	Median 9(IQR 4-16) years		

BMI- Body Mass Index

A total of 235 participants were included in the study, and most of them were female (142, 60.4%), as shown in **Table 2**. The participant's median age was 60, IQR 52-67 years. The Majority (182, 77.5%) of the participants were married, and only a quarter of the participants had attained above secondary level educations.

Slightly more than half of the participants (120, 51.1%) were overweight, and about a quarter (60, 25.5%) had ideal BMI. The median duration of the illness was 9, IQR 4-16 years.

4.3 Lipid profiles Monitoring

The characteristics of the lipid profile are summarized in **Figure 3.** Slightly more than a quarter of the participants (90, 38.3%) had their lipid profile checked frequently (i.e., at least once a year)

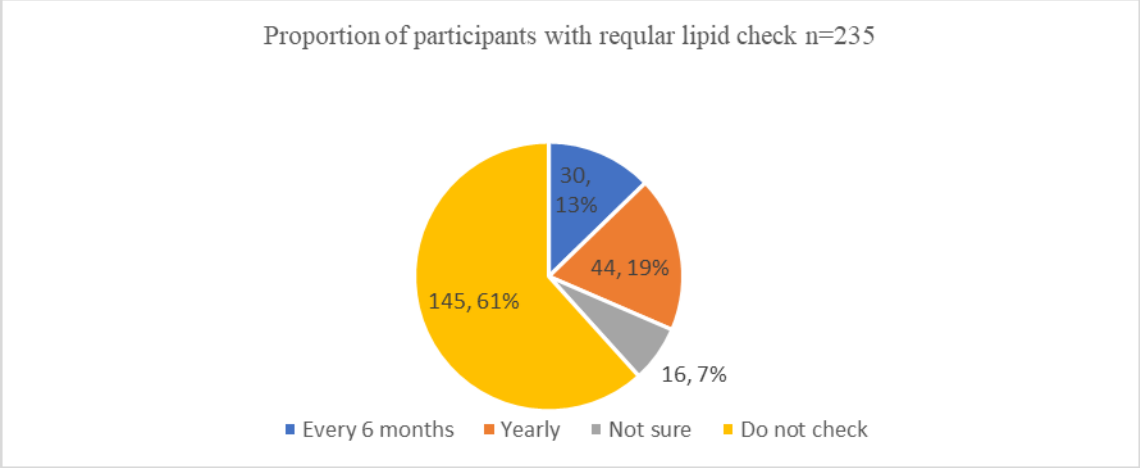


Figure 3. The proportion of participants with regular lipid check

4.4 Lifestyle Modification

The control of dyslipidemias involves strict Adherence to lifestyle modification strategies and cessation of poor health social habits. Out of 235 participants included in the study, 224 (95.3 %) confirmed to be on either one form of lifestyle modification or the other. Out of the 224 participants, 213 (95.1%) agreed to have been counseled by their clinician on dietary modification, including reduced saturated fats and increased fiber intake. However, out of a total of 213 who knew the dietary plan, only 155 (69.2%) strictly adhered to the plan. One hundred and ninety-seven (87.6%) participants admitted had been counseled by their clinician on the importance of the increased physical activity to control the lipid

levels. However, slightly nearly half of these participants 131 (58.5%) strictly adhered to the physical activity plan. Brisk walking for at least 2 km every day was the most preferred at 148(66.1%), and the least used was riding a bicycle 14(6.3%). Five participants admitted to smoke and 15(6.4%) were using alcohol. Beer was the most used alcoholic beverage (11; 73.3%), and most participants took their alcohol weekly (**Table 3).**

Table 3. Lifestyle modification practices in the control of dyslipidemia

Lifestyle Modification Practices	Participants(n-224)	Percentage (%)
Diet		
Reduced saturated fats	178	79.5
Increased fiber intake	207	92.4
Adherence to the dietary plan	155	69.2
Physical activity		
Brisk walking 2 km	148	66.1
Riding a bicycle	14	6.3
Digging	18	8.0
Others*	17	7.6
Adherence to the physical plan	131	58.5
Habits		
Smoking (n=235)	5	2.3
Alcohol intake (n=235)	15	6.4

*Key: *- Household chores, gym*

4.5 Comorbidities

More than half (161, 68.5%) of them had at least one or more comorbidities. Hypertension was the most prevalent comorbidity at 143(88.8%). Summaries are tabulated in (**Table 4)**

Table 4. Comorbidities among T2DM patients

Chronic condition	Frequency (n=235)	Percentage (%)
CHD	3	1.3
CKD	1	.4
HTN	143	60.9
HTN/CHD	2	.9
HTN/CKD	3	1.3
HTN/CVA	2	.9
HTN/Hyperthyroidism	2	.9
HTN/Hypothyroidism	2	.9
Hypothyroidism	3	1.3
None	74	31.5

CHD-Coronary heart disease, CKD- Chronic Kidney disease, HTN- Hypertension, CVA-Cerebrovascular artery disease.

4.6 Other Medications used

The medications prescribed to the patients other than lipid-lowering ones are shown in **Figure 4**. More than half of the participants (193, 82.1%) were on metformin, and thiazolidinediones were the least prescribed (3, 1.3%).

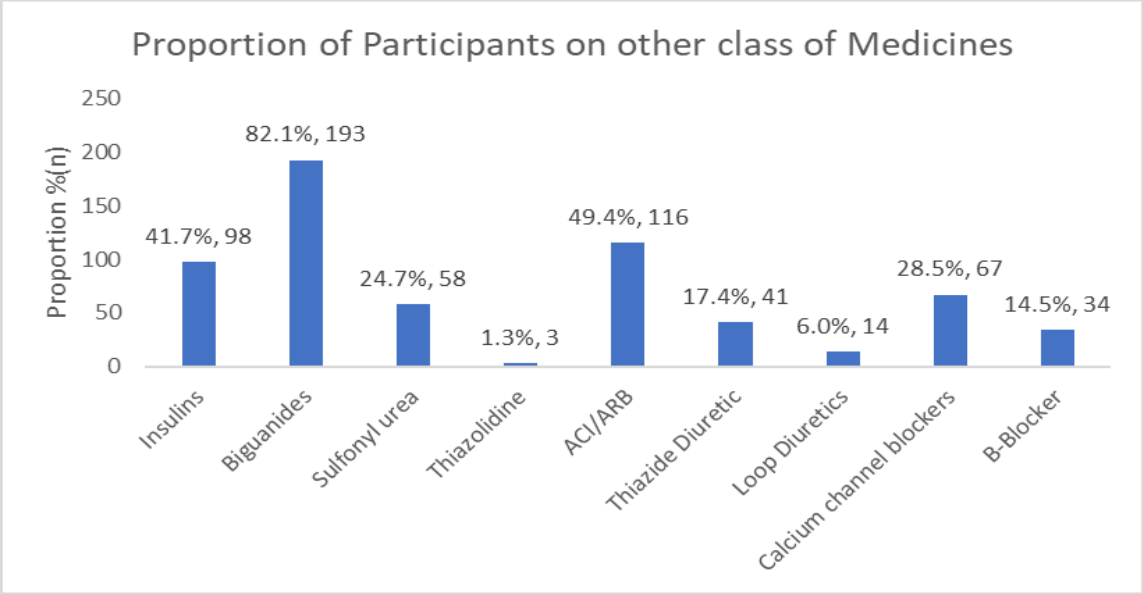


Figure 4. The proportion of medicines prescribed in T2DM patients

4.7 Lipid-lowering agents

Among all Participants, 150(63.8%) were on lipid-lowering drugs, while 83 (36.3%) were not. Only two statins were prescribed- atorvastatin and rosuvastatin- with atorvastatin being the frequently prescribed 147 (62.6%). Most patients were on moderate-intensity statin therapy 135 (57.4%). There was no participant prescribed non-statin therapy (**Table 5**).

Table 5. List of lipid-lowering drugs and intensities

On LLD	**Category**	**Frequency (n=235)**	**Percentage (%)**
Drugs	Atorvastatin	147	62.6
	Rosuvastatin	3	1.3
			63.8
Not on LLD	None	85	36.3
Intensity	High	13	5.5
	Moderate	135	57.4
	Low	2	0.9

***Key**; Low Atorvastatin 5 -10mg, Rosuvastatin 5-10 mg, moderate; Atorvastatin 20mg, Rosuvastatin 20 mg, High; Atorvastatin 40-80mg, Rosuvastatin 40 mg*

4.8 Adherence to Lipid-Lowering Agents (LLA)

A customized Morisky 8 questionnaire adherence scale (MMAS-8) was used to identify the level of Adherence to lipid-lowering agents. The Adherence was categorized as low Adherence if the total crude score on all the eight questions was < 6, Moderate (6 and 7), and High (=8). Nearly half of the study participants (112, 48%) recorded a high adherence to medication. Seventy-four (31.5%) had moderate Adherence, and 49(20.9%) had low adherence to lipid-lowering (**Figure 5**)

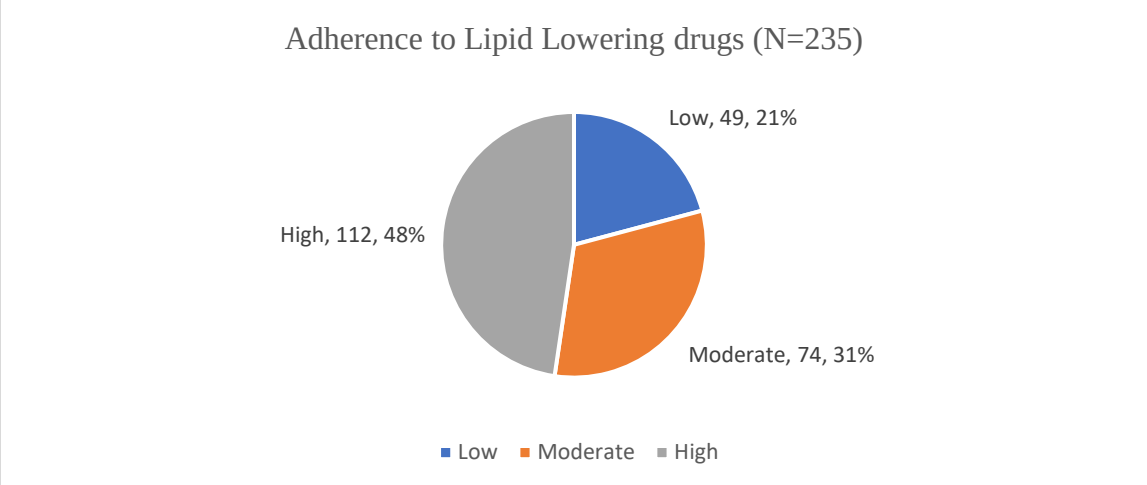
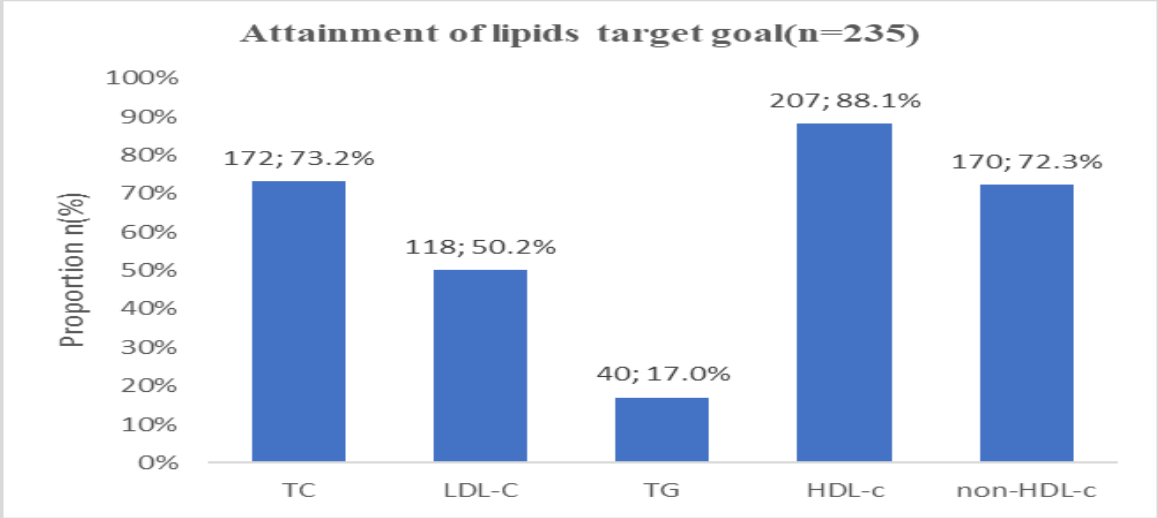


Figure 5. The proportion of participant adhering to Lipid-lowering drugs

4.9 Lipids level control

According to the current guidelines for managing dyslipidemia, the recommended treatment targets for various lipid and lipoproteins include; LDL-C < 2.6 mmol/L, non-HDL < 3.3 mmol/L, TG- 1.7 mmol/l, HDL-c 1.03 and 1.3 mmol/l for male and female, respectively. One hundred and eighteen participants (50.2%) attained the target LDL-C level of < 2.6 mmol/l. The proportion of patient who attained target goals for non-HDL-C, TC, TG, and HDL-C were 72,3%, 73.2 %, 17 %, and 88,15 respectively (**Figure 6)**



***Key**: HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TG, triglyceride*

Figure 6. Proportion of participants with target Lipids levels

4.10 Pattern of lipid profile

Out of the total participants, 174 (74%) had at least or more lipid abnormalities. Several patterns of dyslipidemia were observed **(Table 6)**. Among the isolated dyslipidemia (involving at least one lipid abnormality), elevated LDL-C was the most prevalent (25.9%) followed by elevated TG (23%). Low HDL cholesterol was the least common pattern among the isolated dyslipidemia (5.2%). Elevated LDL-c and TG were the most common combined dyslipidemia (38.5%) pattern. Mixed dyslipidemia (TG, LDL-c, and low HDL-c (typical diabetic dyslipidemia pattern) was observed in 2.9 % of the participants

Table 6. Patterns of dyslipidemia in T2DM patients

Category	Type	Frequency (n=174)	Percentage %
Isolated dyslipidemia (n=94)	Elevated LDL-C	45	25.9%
	Elevated TG	40	23%
	Elevated low HDL	9	5.2%
Combined Dyslipidemia (n=75)	Combined ↑LDL&TG	67	67%
	Combined ↑TG & HDL	8	8%
	Combined ↑LDL& HDL	0	0 %
Mixed dyslipidemia (n=5)	Mixed ↑LDL&TG& HDL	5	2.9%

Key: Isolated dyslipidemia;(anyone lipid abnormal), Combined dyslipidemia (any two-lipid abnormal) Mixed dyslipidemia (all the lipids abnormal TG, LDL, HDL)

4.10 Association between lipid profiles and other variables

The lipid profiles of 235 participants were determined and assessed if they fall within the recommended treatment target levels. Out of the total participants, one hundred and nineteen (51%) had attained the target LDL-C target level of <2.6 mmol/l, the proportion of patients with achieved target non-HDL<3.3 mmol/l, TC<5.2 mmol/l, TG< 1.7mmol/l and HDL-C >1.03 and 1.3 mmol/l (male and female) were, 72.3%, 73.2 %, 17%, and 88.2%, respectively.

4.10.1 Association between LDL-C level control and the social demographic characteristics

Table 7. Association between attaining target LDL-c and social demographic characteristics

Social demographics	Category	LDL-C control		P-Value
		on target (n, %)	not on target (n, %)	
Gender	Male	50 (53.8)	43 (46.2)	0.378
	Female	68 (47.9)	74 (52.1)	
Age*	<55	34 (42.5)	46 (57.5)	0.142
	≥55	84 (54.2)	71 (45.8)	
Marital Status	Not married	28 (53.9)	24 (46.2)	0.553
	Married	90 (49.2)	93 (50.8)	
Education Level	Up to Secondary	86 (48.6)	91 (51.4)	0.384
	Above Secondary	32 (55.2)	26 (44.8)	
Employment status	Employed	59 (48.8)	62 (51.2)	0.646
	Unemployed	59 (51.8)	55 (48.2)	
BMI	Ideal BMI ≤ 24.9	34 (54.0)	29 (46.0)	0.486
	Overweight ≥ 25.0	84 (48.8)	88 (51.2)	
Duration of diabetes*	≤5	45 (54.2)	38 (45.8)	0.408
	6 – 10	27 (54.0)	23 (46.0)	
	11 – 15	15 (36.2)	26 (63.4)	
	>15	31(50.8)	30 (49.2)	

*Key: BMI- body mass index, LLD- Lipid-lowering drugs, BMI-body Mass index, LDL-C low-density lipoprotein cholesterol, * Kruskal Wallis rank test*

Pearson's Chi-square and Kruskal Wallis tests were used to assess the relationship between social demographics and LDL-cholesterol control. Age was reclassified into two categories <55 and > 55 years to allow for straight forward analysis and interpretation of results. The results are summarized in **Table 7**. Fifty (53.8%) of males had LDL-C on target compared to 68 (47.9%) of female, However, no statistically significant difference was observed between gender and LDL-C level control. Similarly, other patients' characteristics

including age, marital status, Educational level, Employment status, BMI, and duration of Diabetes disease had no significant association with LDL-C control.

4.10.2Association between LDL-C level control and medical characteristics

Pearson's chi squire test and Fischer's exact were used in the determination of association between LDL-C control and medical characteristics which included lifestyle modification, concomitant medication, and coexisting comorbidities. No significant association was observed between LDL-C control and the different lifestyle modification practices and the various classes of medication prescribed.

In analyzing the association between the LDL-level control and different comorbidities, a statistically significant relationship was observed with hypertension (p=0.004). The results are summarized in **(Table 8)**

Table 8. Association between LDL-C control and medical characteristics

Lifestyle modification practices	**LDL-C control**		**P-Value**
	On target (n, %)	Not on target (n, %)	
Reduced sat fat (n=213)	89 (50.0)	89 (50.0)	0.543
Increased fiber (n=213)	102 (49.3)	105 (50.7)	0.738
Adherence to Dietary plan: (n=213)	78 (50.3)	77 (49.7)	0.714
Adherence to physical activity plan (n=197)	66 (50.4)	65 (49.6)	0.804
Smoking cessation *	3 (60.0)	2 (40.0)	0.504
Alcohol intake cessation (n=235)	8 (53.3)	7 (46.7)	0.803
Concomitant medications			
B- blockers	21 (61.8)	13 (38.2)	0.145
CCB	30 (44.8)	37 (55.2)	0.293
Loop Diuretics	6 (40.0)	9 (60.0)	0.414
Thiazide Diuretics	21 (50.0)	20 (50.0)	0.976
ACI/ARB	60 (51.7)	56 (48.3)	0.647
Thiazolidines	1 (33.3)	2 (66.7)	0.497
Sulfonyl urea	27 (46.6)	31 (53.5)	0.521
Biguanides	100 (52.4)	91 (49.8)	0.171
Insulins	6 (46.2)	7(53.9)	0.155
Coexisting-Comorbidities			
HTN	87 (57.2)	65 (42.8)	0.004
CHD*	4 (57.1)	3 (42.9)	0.504
CKD *	2 (50.0)	2 (50.0)	0.684
Thyroid Disease*	5 (71.4)	2 (28.6)	0.361

*Key: LDL-C low-density Lipoprotein cholesterol, HTN- Hypertension, CCB- Calcium channel blockers, CHD- Coronary heart disease, CKD- Chronic Kidney Disease, * Fischer's Exact test*

4.10.3: Relationship between the LDL-C level control and lipid-lowering agent's

Summaries of the results are presented in **Table 9**. There was a statistically significant relationship between the use of lipid-lowering drugs and LDL-C level control (p=0.002). However, there was no statistically significant association between different statin intensities and LDL-C level control (p=0.333).

The Morisky adherence score was reclassified by merging low and moderated Adherence into one group 'Non-Adherent,' and a Morisky score of 'high' reclassified as 'adherent.' Significant relationship was observed between the level of adherence to LLD medicines and LDL-C level control (*p=0.011*). The participants with high adherence to lipid-lowering medicines were more likely to attain the target LDL-C levels than those with low adherence

Table 9. Relationship between the LDL-C control and lipid-lowering agent's prescription

Lipid-lowering agent	Category	LDL-C control		P-Value
		LDL- C on target (n, %)	LDL-C not on target (n, %)	
On LLD	Yes	87 (58.0)	63 (42.0)	
	No	31 (36.5)	54 (63.5)	0.002*
LLD intensity	Moderate intensity	81 (59.1)	56 (53.9)	0.363
	High Intensity	6 (46.2)	7 (53.8)	
Adherence to LLD	Adherent	66(58.9)	46(41.1)	0.011*

Key: LLD- Lipid-lowering drug, LDL-C low-density lipoprotein cholesterol

4.11 Association between participant characteristic and Total cholesterol level control

4.11.1 Association between social-demographic characteristics and control of total cholesterol Level

Pearson's chi-square and Kruskal Willis test were used to determine the association between social-demographic characteristics and total cholesterol control. The results of the analysis are summarized in **Table 10**. Among the social demographic characteristics analyzed, none of them had a significant relationship with LDL-C control.

Table 10. Association between attaining target Total cholesterol levels and social demographic characteristics

Social demographics	Category	Total cholesterol Level		P-Value
		on target n (%)	Not on target n (%)	
Gender	Male	74 (79.8)	19 (20.4)	0.074
	Female	98 (69.0)	44 (39.9)	
Age	<55	114 (73.6)	41 (26.8)	0.895
	≥55	58 (72.5)	22 (27.5)	
Marital Status	Not married	39 (75.0)	13 (25.0)	0.739
	Married	113 (72.7)	50 (27.3)	
Education Level	Up to Secondary	126 (71.2)	51 (28.8)	0.225
	Above Secondary	46 (79.3)	12 (20.7)	
Employment status	Employed	90 (74.4)	31 (25.6)	0.784
	Unemployed	83 (72.8)	31 (27.2)	
BMI	Ideal BMI ≤ 24.9	45 (71.4)	18 (28.6)	0.645
	Overweight ≥ 25.0	128 (74.4)	44 (25.6)	
Duration of diabetes *	≤5	63 (75.9)	20 (24.1)	0.947
	6 – 10	38 (70.4)	16 (29.6)	
	11 – 15	28 (73.7)	10 (26.3)	
	>15	44 (73.3)	16 (26.7)	

*Abbreviations: BMI- body mass index, LLD- Lipid-lowering drugs * Kruskal Wallis test done*

4.11.2 Association between Total Cholesterol Level control and clinical characteristics

Among the comorbidities found in the participants, a statistically significant association was only observed between HTN and total cholesterol levels (p=0.017). No statistically significant difference was observed between different lifestyle modification practices, concomitant medications, and attaining the target Total cholesterol goal. The results of the analysis are tabulated in **Table 11.**

4.11.3 Association between Lipid-lowering agents and Total cholesterol level control

An analysis was done to establish the relationship between lipid-lowering drugs and total cholesterol level control (**Table 12**). A statistically significant association was observed between being on LLD and total cholesterol level control (p=0.012). No statistically significant association was established between adherent to LLD and Total cholesterol control.

Table 11. Relationship between total cholesterol control and participants medical characteristics

Lifestyle modification Practices	Total cholesterol level		P-Value
	On target (n, %)	Not on target (n, %)	
Reduced sat fat (n=213)	128 (71.9)	50 (28.1)	0.705
Increased fiber (n=213)	150 (72.5)	57 (27.5)	0.952
Adherence to Dietary plan: (n=213)	112 (72.3)	42 (27.7)	0.985
Adherence to physical activity plan (n=197)	96 (73.3)	35 (26.7)	0.687
Smoking cessation*	3 (60.0)	2 (40.0)	0.612
Alcohol intake cessation*	12 (80.0)	3 (20.0)	0.765
Concomitant-Medications			
B- blockers	25 (73.5)	9 (26.5)	0.962
CCB	49 (74.6)	18 (26.9)	0.990
Loop Diuretics*	13 (86.7)	3 (13.3)	0.366
Thiazide Diuretics	30 (75.6)	10 (25.0)	0.777
ACI/ARB	89 (77.6)	27 (23.3)	0.227
Thiazolidines *	2 (66.7)	1 (33.3)	1.000
Sulfonyl urea	44 (75.9)	14 (24.1)	0.597
Biguanides	145 (75.9)	46 (24.1)	0.049
Insulins	71 (72.5)	27 (27.6)	0.828
Co-existing Comorbidities			
HTN	119 (78.7)	33 (20.3)	0.017
CHD*	3 (60.0)	2 (40.0	0.612
CKD*	2 (50.0)	2 (50.0)	0.292
Thyroid Disease*	5 (71.4)	2 (28.6)	1.000

*Key: HTN; Hypertension, CHD; Coronary heart disease, CKD; Chronic kidney Disease, TC Total Cholesterol * Fischer's exact test, Bold -Statistically significance*

Table 12. Association between TC level control, lipid-lowering drugs, and Adherence

Lipid-lowering agent	Category	T-C control		P-Value
		on target (n, %)	not on target (n, %)	
On LLD	Yes	118 (78.7)	32 (21.3)	
	No	54 (63.5)	31 (36.5)	0.012*
LLD intensity	Moderate intensity	110 (80.3)	27 (21.3)	
	High Intensity	8 (61.5)	5 (38.5)	0.115
Morisky score	Adherent	87 (77.7)	25 (22.3)	0.138

Key: LLD- Lipid-lowering drug, TC Total cholesterol

4.12 Association between participants characteristics and Triglyceride level control

4.12.1 Association between social-demographic characteristics and triglyceride level control

A bivariate analysis was done to determine the association between social-demographic characteristics and control of triglyceride levels, and the results are tabulated in **Table 13**

Among the participant social-demographic characteristics none had a statistically significant association with triglyceride level control.

Table 13. Association between Triglyceride level Control and social demographic characteristics

Social demographics	Category	TG Level control		P-Value
		On target (n, %)	not on target (n, %)	
Gender	Male	15 (16.3)	25 (17.6)	0.768
	Female	78 (83.8)	117 (82.4)	
Age	<55	13 (35.5)	27 (67.5)	0.883
	≥55	27 (67.5)	128 (65.6)	
Marital Status	Not married	9 (17.3)	43 (82.3)	0.950
	Married	31 (16.9)	155 (83.1)	
Education Level	Up to Secondary	32 (18.1)	145 (81.9)	0.451
	Above Secondary	8 (13.8)	50 (86.2)	
Employment status	Employed	21 (18.1)	100 (82.6)	0.076
	Unemployed	19 (16.7)	95(83.3)	
BMI	Ideal BMI ≤ 24.9	15 (24.2)	47 (75.8)	0.080
	Overweight ≥ 25.0	25 (14.5)	148 (75.8)	
Duration of diabetes*	≤5	41 (49.4)	42 (50.6)	0.987
	6 – 10	27 (50.0)	27 (50.0)	
	11 – 15	21 (55.3)	17 (44.7)	
	>15	31 (51.7)	29 (48.3)	

*Key: BMI- body mass index, LLD- Lipid-lowering drugs, TG – Triglycerides * Kruskal Wallis test*

4.12.2 Association Triglyceride level control and participants medical characteristic

A comparison was made between triglyceride level control and participants' medical characteristics were analyzed using Pearson's chi-square and Fischer's exact, and the result was presented in **Table 14.** Though most participants were using different lifestyle modification practices to control their lipid levels, no statistically significant association was observed between the lifestyle practices used and TG control.

Among the various classes of medication prescribed, CCBs prescription was the only one with a significant association with TG level control (p=0.011). No significant association was observed between co-existing comorbidities and triglyceride target level control.

Table 14. Association between triglyceride level control and clinical characteristics

Lifestyle modification practices	TG Level		P-Value
	On target (n, %)	Not on target (n, %)	
Reduced saturated fat (n=213)	31 (17.4)	147 (82.6)	0.771
Increased fiber (n=213)	38 (18.4)	169 (81.6)	0.221
Adherence to Dietary plan: (n=213)	29 (18.6)	126 (81.3)	0.492
Adherence to physical activity plan (n=197)	23 (17.4)	108 (82.4)	0.782
Smoking cessation*	1 (20.0)	4 (80.0)	1.000
Alcohol intake cessation*	1 (6.6)	14 (73.3)	0.478
Medications			
B- blockers	7 (29.6)	27(79.4)	0.550
CCB	18 (26.9)	49 (73.1)	0.011
Loop Diuretics	2 (18.3)	13 (86.7)	1.000
Thiazide Diuretics	7 (17.5)	33 (82.5)	0.930
ACI/ARB	18 (15.5)	98 (84.5)	0.545
Thiazolidines	0 (0.0)	1 (100.0)	1.000
Sulfonylurea	7 (12.1)	51 (87.9)	0.248
Biguanides	33 (17.3)	158 (82.7)	0.828
Insulins	21 (21.4)	77 (78.6)	0.128
Comorbidities			
HTN	28 (14.4)	124 (81.6)	0.440
CHD	1 (20.0)	4 (80.0)	1.000
CKD	2 (50.0)	2 (50.0)	0.135
Thyroid Disease	7 (14.3(	6 (85.7)	1.000

*Abbreviations: ACI/ARB- Angiotensin-converting inhibitor/ Angiotensin Receptor Blocker, HTN- Hypertension, CHD; Coronary heart disease, CKD; Chronic kidney Diseases, CCB- Calcium channel blockers, TG- Triglyceride, * Fischer's exact test, Bold- Statistically significant test*

4.12.3 Association between triglyceride level control and Lipid-lowering drugs

As illustrated in **Table 15**. There was a statistically significant association between being on LLD and Triglyceride level control. However, no statistically significant difference was observed between different statin intensities and adequate control of the triglyceride level. Participant adherence was significantly associated with triglyceride level control (p=0.039)

Table 15. Relationship between the Triglyceride Level control and use of lipid-lowering agents

	Category	Triglycerides Level control		P-Value
		On target (n, %)	Not on target (n, %)	
On LLD	Yes	31 (20.7)	119 (79.3)	**0.048**
	No	9 (10.6)	76 (89.4)	
LLD intensity*	Moderate intensity	31 (22.6)	106 (79.3)	0.071
	High Intensity		13 (100)	
Adherent to LLD	Adherent	25 (22.3)	87 (77.7)	**0.039**

*Key; LLD- Lipid-lowering drugs, MMAS- Morisky adherence score, TG- triglycerides *Fischer's exact, bold- statistically significant test*

4.13 Association between participants characteristics and High-Density Lipoprotein cholesterol level control

4.13.1 Association between social-demographic characteristics and HDL-C level control

No significant association was observed between participant characteristics and HDL-C level control. The results are summarized in **Table 16**

Table 16. Association between target HDL-C level control and social demographic characteristics

Social demographics	Category	HDL-C control		P-Value
		On Target (%)	Not on target n (%)	
Gender	Male	80 (86.0)	13 (13.9)	0.652
	Female	125 (80.0)	17 (11.97)	
Age	<55	69 (33.3)	11 (39.3)	0.727
	≥55	131 (66.5)	17 (60.7)	
Marital Status	Not married	43 (82.7)	9 (17.3)	0.266
	Married	166 (88.5)	21 (11.5)	
Education Level	Up to Secondary	155 (87.6)	22 (12.4)	
	Above Secondary	52 (89.7)	6 (10.4)	0.671
Employment status	Employed	102 (89.5)	12 (10.5)	0.318
	Unemployed	103 (85.1)	18 (14.9)	0.233
BMI	Ideal BMI ≤ 24.9	52(83.9)	10 (16.1)	
	Overweight ≥ 25.0	18 (10.5)	154 (89.5)	
Duration of diabetes*	≤5	16 (19.3)	67 (80.7)	0.641
	6 – 10	5 (9.3)	49 (90.7)	
	11 – 15	2 (5.3)	36 (94.7)	
	>15	6 (10.0)	54 (90.0)	

*Abbreviations: BMI- body mass index, LLD- Lipid-lowering drugs, HDL-C High- density lipoprotein cholesterol * Kruskal Wallis test*

4.13.2 Association between HDL-C level control and lifestyle modification practice

The association between HDL-C control and participants' medical characteristics (lifestyle modification practices, other medication prescribed, and co-existing comorbidities) were determined using chi-square and Fischer's exact test. The results are summarized in **Table 17**. No statistically significant relationship was observed between the various lifestyle modification practices, comorbidities, and an increase in HDL -Cholesterol Levels. Metformin was the most prescribed medicine in the study participants and had a statistically significant association with the target HDL-C level control (p=0.021).

Table 17. Association between target HDL-c level control and participants' medical characteristics

Lifestyle modification practices	**HDL Level control**		**P-Value**
	On target (n, %)	**Not on target (n, %)**	
Reduced saturated fat (n=213)	159 (89.3)	19 (10.7)	0.938
Increased fiber (n=213)	186 (89.9)	21 (10.1)	0.166
Adherence to Dietary plan: (n=213)	139 (89.7)	16 (10.3)	0.805
Adherence to physical activity plan (n=197)	139 (89.7)	16 (10.3)	0.805
Smoking *	3 (60.0)	2 (40.0)	0.123
Alcohol intake *	13(86.7)	2 (13.3)	1.000
Medications			
B- blockers	31 (91.2)	3 (8.8)	0.456
CCB	57 (85.1)	10 (14.9)	0.531
Loop Diuretics*	14 (93.3)	1 (6.7)	0.700
Thiazide Diuretics	34 (85.0)	6 (15.0)	0.642
ACI/ARB	99 (85.3)	17 (14.6)	0.392
Thiazolidines *	3 (100.0)	0 (0.0)	1.000
Sulfonylurea	52 (89.7)	6 (10.3)	0.524
Biguanides	162 (84.8)	29 (15.2)	**0.021**
Insulins	84 (85.7)	14 (14.3)	0.555
Commodities			
HTN	129 (84.9)	23 (15.1)	0.141
CHD*	4 (80.0)	1 (20.0)	0.498
CKD *	4 (100.0)	0 (0.00)	1.000
Thyroid Disease*	5 (71.4)	2 (28.6)	0.626

*Abbreviations: ACI/ARB- Angiotensin-converting inhibitor/ Angiotensin Receptor Blocker, HTN-Hypertension, CHD; Coronary heart disease, CKD; Chronic kidney Diseases, CCB- Calcium channel blockers, HDL- High density, * Fischer's exact test, Bold- Statistically significant test*

4.13.3 Association between HDL-C level control and LLD

The association between HDL- cholesterol level control was analyzed against the use of LLD and adherence using chi-square and Fischer's exact test. Results were tabulated in **Table 18**. A significant association was observed between HDL-C level control and the use of LLD (p=0.005). Adherence to lipid-lowering drugs was also significantly associated with HDL-C control. Participants who reported adherents were more likely to have increased HDL-C levels (p=0.009).

Table 18 Relationship between the HDL-C level control and lipid-lowering agents

Lipid-lowering agent	Category	HDL-C level control		P-Value
		Low (n, %)	High (n, %)	
On LLD	Yes	124 (82.7)	26 (17.3)	0.005
	No	81 (95.3)	4 (4.7)	
LLD intensity*	Moderate intensity	116 (84.7)	21 (15.3)	0.438
	High Intensity	10 (76.9)	3 (23.1)	
Adherent to LLD	Adherent to LLD	91 (81.3)	21 (18.75)	0.009

*Key; HDL- High- density Lipoprotein, LLD- Lipids lowering drug * Fischer's exact test, bold- Significant test*

4.14 Association between participants characteristics and non-HDL-C

4.14.1 Association between social-demographic characteristics and non-HDL-C level control

Pearson's chi-square and Kruskal Wallis test were used to determine the association of social demographics and target non-HDL cholesterol level control. The results are summarized in **Table 19**. Among the social-demographic characteristics, educational level was the only one with a statistically significant association with non-HDL-C (p=0.041).

Participants with a university education were more likely to attain target non-HDL cholesterol than those with up to secondary education.

Table 19 Association between non-HDL cholesterol and social-demographic characteristics

Social demographics	**Category**	non-HDL-C **control**		**P-Value**
		On Target (%)	Not on target n (%)	
Gender	Male	71 (76.3)	22 (23.7)	0.267
	Female	99 (69.7)	43 (30.3)	
Age	<55	113 (72.9)	42 (27.1)	0.836
	≥65	57 (71.3)	23 (28.8)	
Marital Status	Not married	130 (71.0)	53 (82.9)	0.402
	Married	40 (76.9)	12 (23.1)	
Education Level	Above Secondary	48 (82.8)	10 (17.2)	0.041
	Up to Secondary	122(68.9)	55 (31.1)	
Employment status	Employed	88 (72.7)	33 (27.3)	0.891
	Unemployed	82 (71.9)	32 (28.1)	
BMI	Ideal BMI ≤ 24.9	46 (74.2)	16 (25.8)	0.704
	Overweight ≥ 25.0	124 (71.7)	49 (28.3)	
Duration of diabetes*	≤5	16 (19.3)	67 (80.7)	0.919
	6 – 10	5 (9.3)	49 (90.7)	
	11 – 15	2 (5.3)	36 (94.7)	
	>15	6 (10.0)	54 (90.0)	

*Abbreviations: BMI- body mass index, LLD- Lipid-lowering drugs, HDL-C High- density lipoprotein cholesterol * Kruskal Wallis test, Bold-Statistically significance*

414.2 Association between non-HDL-C level control and medical characteristic.

Participants' medical characteristics including lifestyle modification practices, concomitant medication prescribes, and co-existing comorbidities were analyzed against target non-HDL-C level control using Chi-square and Fischer's exact tests. Summary results are tabulated in (**Table 20**).

No statistically significant relationship was established between the lifestyle modification practices and the control of non-HDL-C. Likewise among the different medication prescribed no significant association was observed with target non-HDL-C levels control. Among the co-existing comorbidities analysis, a significant association was observed between hypertension (p=0.014) and attaining target non-HDL-c level.

Table 20 Association between non-HDL-c control and participants medical characteristics

Lifestyle modification practices	non-HDL Level control		P-Value
	On target (n, %)	Not on target (n, %)	
Reduced saturated fat (n=213)	130 (73.0)	48 (26.9)	0.920
Increased fiber (n=213)	150 (72.5)	57 (27.5)	0.438
Adherence to Dietary plan: (n=213)	112 (72.7)	43 (27.7)	0.638
Adherence to physical activity plan (n=197)	94 (71.8)	37 (28.6)	0.863
Smoking*	4 (80.0)	1 (20.0)	1.000
Alcohol intake *	11(73.3)	4 (26.7)	1.000
Medications			
B- blockers	27 (79.41)	7 (20.59)	0.319
CCB	47 (70.2)	20 (29.9)	0.635
Loop Diuretics	12 (80.0)	3 (20.0)	0.766
Thiazide Diuretics	27 (67.5)	13 (32.5)	0.452
ACI/ARB	83 (71.6)	33 (28.5)	0.790
Thiazolidines *	3 (100.0)	0 (0.00)	0.563
Sulfonylurea	39 (67.2)	19 (37.8)	0.317
Biguanides	141 (73.4)	50 (26.2)	0.290
Insulins	72 (73.5)	26 (26.5)	0.743
Comorbidities			
HTN	118 (77.6)	34 (22.3)	**0.014**
CHD*	3 (60.0)	2 (40.0)	0.618
CKD *	3(75.0)	1 (25.0)	1.000
Thyroid Disease	6 (87.7)	1 (85.29)	0.674

*Abbreviations: ACI/ARB- Angiotensin-converting inhibitor/ Angiotensin Receptor Blocker, HTN- Hypertension, CHD; Coronary heart disease, CKD; Chronic kidney Diseases, CCB- Calcium channel blockers, HDL- High density, * Fischer's exact test, Bold- Statistically significant test*

4.14.3 Association between non-HDL-C level control, LLD and Adherence

A statistically significant association was found between the use of LLD and non-HDL-C target goal attainment (p=0.010) (**Table 21**). Being on LLD influences the attainment of recommended non- HDL- C goal.

Table 21 Association between non-HDL-C level control in T2DM and lipid-lowering drugs

Lipid-lowering agent	Category	HDL-C level control		P-Value
		On target (n, %)	Not on target (n, %)	
On LLD	Yes	117 (78.0)	33 (22.0)	**0.010**
	No	53 (62.4)	32 (37.7)	
LLD intensity	Moderate intensity	109 (79.6)	28 (20.4)	0.134
	High Intensity	8 (61.5)	5 (38.5)	
Morisky score	Adherent to LLD	85 (75.9)	27 (24.1)	0.245

Key; HDL- High- density Lipoprotein, LLD- Lipids lowering drug, bold statistically significant result.

4.15 Independent predictors for control of Lipid Levels

To determine the covariates lipid level control, forward stepwise multivariate logistic regression was done. The crude odds ratio and adjusted odds ratio after univariate and multivariate analysis are summarized in **Table 22.** The odds of attaining target LDL-C level among participants on Lipid-lowering drug(statin) was 2.3 times more than the odds of those not on statins, and this was statistically significant (aOR 2.3; CI (1.26,4.03); *p*=0.005). Likewise, participants with higher adherence to LLD had twice the probability of attaining target LDL-C level compared to those not adherent. This relationship was positive and statistically significant (aOR 2.0; CI (1.16,3.47); *p*=0.007). The recommended treatment target for total cholesterol in T2DM patients is <5.2 mmol/ l. Participants using LLD had twice the probability of attaining adequate TC levels control compared to those, not on LLD. (aOR-2.0; CI (1.07-3.71); *p*=0.029). Female participants had 2 times the odds of having controlled total cholesterol levels compared to the male gender (aOR 2.0; CI (1.07-3.71); p=0.22). After univariate analysis, hypertension was found to be a significant predictor for TC level control, the significance was, however, lost after multivariate analysis (aOR-1.7; CI (0.31-1.08); p=0.091). which may imply a possible confounding effect.

Calcium channel blockers were found to be a predictor for TG level control (aOR 2.5 CI (1.19-5.39): p=0.029). Participants on CCBs were 2.5 times likely to attain a target TG level of < 1.7 mmol/l than those who were not on CCBs. This may be explained by the possible effect of calcium channel blocker (amlodipine) on reducing triglyceride levels.

The independent predictors for HDL-C level control were, the use of LLD (aOR 0.2:CI(0.07-0.65); p=0.045) , adherence to LLD (aOR 0.3;CI(0.12-0.69); p=0.05) and the use of biguanides (metformin) (aOR 0.1(0.01-0.96); p=0.07).

Non- HDL- Cholesterol is often considered a secondary target in the control of dyslipidemia after attaining the LDL-C target. Participants with above secondary educations had 2.1 times the odds of attaining target non-HDL-c level control of <3.37 mmol/ l than the odds of those with up to secondary level and below (aOR 2.2; CI (1.00-4.87). This was also statistically significant (p=0.040). Similarly, participants on Lipid-

lowering drug (statin) had 2 times the probability of having adequate non-HDL-c Control compared to those who had no statin prescription (aOR- 2.0; CI (1.01-3.38); p=0.024).

Hypertension was a significant predictor of non-HDL-C such that participants who were having hypertension were 2.1 times likely to attain the non-HDL-C target than those without HTN. (aOR-2.0; CI (1.04-3.67); p=0.036).

Table 22. Bivariate and Multivariate Logistic regression for correlated of Lipid level control among T2DM patients.

Lipids	**Variable**	**Bivariate Logistic**		**Multivariate Logistic**	
		COR 95% CI	P-value	aOR 95% CI	P-value
LDL-Cholesterol	On LLD	2.2 (1.39-4.16)	**0.002***	2.3 (1.26-4.29)	**0.005***
	Adherence to LLD	1.9 (1.17-3.29)	**0.011***	2.0 (1.16-3.47)	**0.007***
	HTN	2.2 (1.30-3.89)	**0.004***	1.6 (0.32-1.02)	0.134
	Metformin	1.5 (0.81-3.08)	0.173	1.5 (0.73-3.19)	0.241
	Gender	1.3 (0.74-2.13)	0.379	1.5 (0.88-2.74)	0.126
	Beta blockers	1.7 (0.82-3.64)	0.148	1.6 (0.70-3.53)	0.271
	Age	1.4 (0.98-1.87)	0.064	1.1 (0.78-1.57)	0.546
Total Cholesterol	Gender	1.7 (0.94-3.24)	0.076	2.0 (1.03-3.72)	**0.041***
	On LLD	2.1 (1.17-3.82)	**0.013***	2.0 (1.07-3.71)	**0.022***
	HTN	2.0 (1.13-3.69)	**0.018***	1.7 (0.92-3.21)	0.091
	Metformin	2.0 (0.99-3.96)	0.052	1.8 (0.88-3.76)	0.103
	Adherence to LLD	1.6 (0.87-2.80)	0.125	1.8 (0.94-4.07)	0.078
	Age	1.5 (0.75-3.16)	0.621		
	Education Level	1.5 (0.75-3.17)	0.228	1.6 (0.74-3.42)	0.226
Triglycerides	On LLD	2.2 (0.99-4.89)	0.052	2.1 (0.96-4.96)	0.061
	Adherence to LLD	2.1 (1.03-4.16)	0.042	1.9 (0.96-4.08)	0.063
	Gender	0.9 (0.44-1.81)	0.768		
	CKD	5.1 (0.69-37.17)	0.110	4.5 (0.46-45.92)	0.196
	CCBs	2.4 (1.21-4.92)	**0.013***	2.5 (1.19-5.39)	**0.029***
	BMI	0.5 (0.36-0.95)	0.083	2.0 (0.95-4.28)	0.067
HDL-Cholesterol	On LLD	0.2 (0.79-0.06)	0.009	0.2 (0.07-0.65)	**0.045***
	Adherence	0.3 (0.15-0.78)	**0.011***	0.3 (0.12-0.69)	**0.005***
	Biguanides	0.1 (0.07-0.98)	**0.048***	0.1 (0.01-0.96)	**0.007***
Non-HDL-C	Education level	2.1 (1.02-4.59)	**0.040***	2.2 (1.00-4.87)	**0.040***
	Adherence to LLD	1.4 (0.78-2.50)	0.246		
	Gender	1.4 (0.77-2.55)	0.268		
	On LLD	2.1 (1.19-3.84)	**0.011***	2.0 (1.01-3.88)	**0.024***
	HTN	2.1 (1.15-3.71)	**0.015***	2.0 (1.04-3.67)	**0.036***

*Key; LLD- Lipid-lowering Drugs, HTN- hypertension, HDL-High-density Lipoprotein, CKD-chronic Kidney Disease, CCB- Calcium channel blocker, * Statistically significant result*

CHAPTER FIVE: DISCUSSION, SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.1Introduction

This chapter discusses the findings of the study. The conclusion and recommendations for possible policy and practice guidelines review are also summarized in this chapter.

5.2 Discussion

Most of the respondents were female, and this compares with findings from similar studies in South Africa and Kenya (67,68) and contrasts the findings from studies in Bangladesh, Yemen, and Nepal (69–71), where no gender difference was reported. The reasons for this variation could be attributed to the gender differences in health-seeking behavior since a study in Kenya on the prevalence of T2DM did not report any gender variation in the prevalence of diabetes (72).

In our study, most participants had a modest formal education, whereby only 25 % of the participants had attained above secondary level education. The median age of participants was 60 (IQR 52-67) years, signifying that most patients were born in the pre-independence era and may not have had equal opportunity to attend schools, which was scarce at the time.

Ideal BMI was maintained in less than 25% of the participants, with the majority being overweight and obese. This was consistent with data from other settings, which revealed a high prevalence of overweight and obesity among T2DM. For instance, a study in Australia (73), reported that 53% of T2DM patients were obese, and 34% were overweight; in Yemen (74), the prevalence of obesity was high. In studies done in Sub-Saharan Africa, the prevalence of overweight and obesity in diabetes were varied (75) (76). In Sudan (77), the prevalence of obesity among diabetes patients was 24.5%, with women being most affected, and in a large study in Uganda (78), the prevalence of overweight and obesity in T2DM was 36% and 27%, respectively. This may imply that overweight and obesity is a global challenge, especially in the diabetic population. The rising rate of urbanization and globalization with associated lifestyle changes and physical inactiveness may be the reason for the high prevalence of overweight and obesity.

The majority of the participant had hypertension, this result concurs with finding from the previous study. (79). Poorly controlled hyperglycemia in diabetes can cause vascular

damage, which leads to vascular complications such as atherosclerosis and hypertension; thus, a more comprehensive approach in the treatment of T2DM by managing associated comorbidities is essential for improved cardiovascular risk control.

Less than half (38.8%) of the patients had their lipid profile checked regularly. According to the American College of Cardiology/American Heart Association guidelines for treating dyslipidemia (80), high cardiovascular risk patients, including those with diabetes, should have their lipid levels checked more often, at least every 3 to 12 months. This is necessary, especially after initiation of lipid-lowering therapy, to assess for adherence and safety. Several factors, including the clinician's inertia to request the test, the additional cost involved, and the inconveniences to the patients associated with the test, may be attributed to the observed discrepancy. Strategies to encourage routine monitoring of patient lipid profiles may improve the control of dyslipidemia.

Slightly more than half of the study participants were prescribed lipid-lowering drugs, with statins being the only agents prescribed. This was markedly higher compared to the findings in a similar study conducted in the same setting (81). Atorvastatin and rosuvastatin were the only statins prescribed, with atorvastatin moderated intensity being the most prescribed. This was comparable to studies in Malaysia, Netherlands, and Scotland (56,57,82). A slightly lower LLD prescription rate was reported in studies done in Ethiopia and India (59,83).

In most guidelines on cholesterol management, statin therapy should be initiated in type 2 diabetes patients aged between 40-75 years without estimating the 10-year ACVD risk (84,85). Suboptimal utilization of LLD may be attributed to many factors that are either patients or the prescriber related. For instance, patients often discontinue statin therapy due to associated side effects or lack of knowledge on the importance of statin therapy (61–63). Prescriber's knowledge and attitude may influence the rate of lipid-lowering drug prescriptions. Specialist doctors are more likely to prescribe statin than doctors in general practice (55,86). Other factors, including the availability of lipid-lowering medicine, the cost of the medicines is also likely to influence the rate of prescription of lipid-lowering agents.

Numerous pieces of evidence have demonstrated the effectiveness of statins in lowering lipids levels, especially low-density lipoprotein cholesterol; however, this effect may not be realized in the face of suboptimal adherence to lipid-lowering drugs (61). In the present study, adherent to LLD was reported in about half the participants on LLD. This agrees with a Saudi Arabia study (87). In contrast, similar studies in Malaysia and Saudi Arabia reported relatively higher adherence rates (61,88). The observed variation may be attributed to the different adherence tools used; for instance, the proportion of days covered by the drug (PDC) was used to estimate adherence in the Saudi study, while the medication compliance questionnaire (MCQ) was used in the Malayan study. Patients' related factors including; negative attitude toward medication, lack of understanding of the cost-benefit of treatment, medication-related adverse events, and frustration from the inadequate therapeutic response, may also affect medication adherence (62,89). Additionally, patient education on the use of statins and the importance of adhering to treatment may help reduce the rate of non-adherence to LLD.

Dietary modification and increased physical activeness have been shown to reduce lipid levels and weight, especially in obese individuals (52,90), and thus form part of the fundamental approach used to manage dyslipidemia(19,36,80). In this study, more than half of the participants reported adherent to dietary modification plans and engaged in physical activities. These findings compare to a study done in Ethiopia (76), where over half of the participants had a proper dietary intake and engaged in walking as part of their daily exercise. In contrast, a study by J. Parajuli *et al*. reported a relatively low adherence rate to dietary modification and physical activity plans (91). The observed variation may be attributed to the differences in the level of counseling on nutritional requirements in diabetic treatment.

We found the prevalence of alcohol intake and smoking among participants to be 7% and 2% respectively. This proportion was relatively lower compared to similar studies in a different setting. In a large observational study in Sweden, the prevalence of smoking among T2DM patients was found to be 17.1% (92). Similarly, a study in America reported a prevalence of 10.1 % among T2DM patients (93). Population and cultural differences may probably explain the variation in the finding, additionally, these were large population

studies are likely to give a better epidemiological finding. Another possible reason for the observed variation may be due to patients reluctant to report if they actively smoke or take alcohol.

The patterns and prevalence of lipid abnormalities in T2DM vary significantly depending on individuals' age, gender, nutritional status, glycemic control, lipid therapy, and other factors (4). In our study, the overall prevalence of dyslipidemia was 74%, which compares findings from similar studies in other settings, ranging from 67.1% to 88.9%.(69,94,95).

We found isolated dyslipidemia with high LDL-C to be the most common pattern. In contrast, a study in Nepal involving a similar patient cohort reported low HDL as the common pattern (71). Another study in India found combined dyslipidemia with elevated LDL-C and low HDL-C to be the prevalent dyslipidemia pattern (96). In the present study, the second prevalent pattern of dyslipidemia was combined dyslipidemia (at least two lipid abnormalities) with elevated LDL-C and TG (38.5%) being the most common. A hospital observational study in Tanzania reported combined high TG and low HDL-C to be the frequent lipid pattern (97). The differences in the patterns of lipid profiles observed could be due to variations in dietary habits.

A typical lipid profile pattern in T2DM involves elevated triglyceride levels, low levels of HDL-C, and a high level of small dense LDL-C (98). In our study, mixed dyslipidemia of elevated TG, low HDL, and high LDL-c was found in 2.1% of participants. More than half of the study participants were on LLD which may explain the observed variation.

Although most of the study participants had attained ideal total cholesterol levels, a lower proportion achieved target LDL-C and TG levels. This study result agrees with the findings of other similar studies across the world, reflecting the high prevalence of uncontrolled lipid profiles in diabetes patients. A study in South Africa reported sub-optimal target lipid levels attainment (70). A study in Malaysia, reported a relatively lower rate of LDL-cholesterol control whereby only 26.9% of the participants attained the recommended target.

In the univariate analysis, a significant association was established between LDL-C control and hypertension, the use of Lipid-Lowering agents, and adherence to lipid-lowering drugs.

However, after a multivariable logistic analysis, adherent and use of lipid-lowering agents were the only independent predictors for LDL-C control. A study done in Ireland involving T2DM patients reported that patients with adherent Morisky score were more likely to achieve the LDL-C target level (67).

Similarly, a study in Saudi Arabia found adherent to LLD and glycemic control (HbAlC <7%) to be an independent predictor for LDL-C level control (90). However, a study in Malaysia (63) observed no statistically significant association between adherence and LDL-c level control. In these studies, a different tool other than Morisky was used to assess adherence to lipid-lowering agents, explaining the observed variation.

In the current study, the proportion of participants who had attained the optimal non-HDL-c level of <3.37momol/l was 72.3%. This finding was comparable to one American registry survey, which found the proportion of patients with attained LDL-C level <2.59 and non-HDL-C level <3.37 mmol/l among T2DM patients to be 73.9% and 72 %, respectively (93). In one hospital study in Southeast China, 64.6% of the T2DM patients sampled had achieved optimal non-HDL-C level. Unlike in our study, this was a more extensive hospital study, which included 56.784 in-patients with T2DM (25).

We found the proportion of participants with adequate TG <1.7 mmol/l, and HDL-c ≥ 1.04 mmol/l (men) and > 1.30 (female) control to be 17% and 88.3%, respectively. A large multicenter cross-sectional study done in India reported the attainment rate for TG and HDL-c among type 2 diabetic patients to be 60.4% and 57.5%. A study by S, Li *et al.* done in a tertiary hospital in China revealed a 64.6% and 49.9% control rate for TG less than 1.7 and HDL-C ≥ 1.04 and ≥1.30 (male and female), respectively.

5.3 Strength and Weakness

This study highlighted important predictors for lipid level control in T2DM, additionally, the level of patient's adherence to lipid-lowering was also reported. However, since this was a cross-sectional study design it was prone to bias including response bias, measurement bias, and investigator bias, which may have influenced the result, for instance, patients who were active smokers or take alcohol may have reported not to be smoking or taking alcohol. Additionally, possible errors may have been made during the measurement and interpretation of patient lipid profile level. Triglycerides levels in the

blood are known to increase sharply immediately after a fatty meal, thus, the levels could have been overestimated in those participants who had not fasted before the test. Glycemic control is one factor that could influence lipid level; however, this was not analyzed in the current study.

5.4 Summary & Conclusion

1. This study's findings revealed suboptimal control of dyslipidemia among T2DM patients attending the Diabetic Clinic in KNH. Although most study participants were within target levels for total cholesterol and HDL-c cholesterol, nearly half of them had poorly controlled LDL-C, and more than two-thirds had poorly controlled triglyceride levels.
2. Lipid-lowering agents are underutilized in that slightly more than half of all eligible patients were on statin therapy.
3. Statins are the only lipid-lowering agent prescribed to diabetic patients, with atorvastatin being the most prescribed.
4. The adherence to lipid-lowering agents was suboptimal, with less than half of the study participants reported adherent to therapy.
5. Prescription of Lipid-lowering agents and the adherence to LLD were found to be strong predictors for attaining target LDL-c, non-HDL-c control.
6. Although most of the participants were aware of the recommended lifestyle modification strategies in controlling dyslipidemia few were strictly following the plan.

5.5 Study Recommendations

5.5.1Policy and Practice

- The management of diabetes should involve a comprehensive approach by controlling all associated comorbidities, including hypertension and dyslipidemia.
- Efforts to ensure regular monitoring of patient lipids profile and adherence to LLD can help improve the control of dyslipidemia in T2DM.
- Sensitization of patient and clinicians on the use of a lipid-lowering agent should be considered to improve the management of diabetic dyslipidemia

- Availing quality and cost-effective Lipid-lowering medication may help improve treatment adherence.

5.5.2 Further research

Adherence to the lipid-lowering agent was suboptimal. This study did not investigate the cause of the patient's non-adherence; future prospective studies are required to help bridge this gap. The present study was a cross-sectional study that is limited to establishing a causal relationship. A more extensive study such as a prospective cohort study will be necessary to confirm the finding of this study

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APPENDICES

Chapter 2 Appendix 1 ETHICAL APPROVAL

UNIVERSITY OF NAIROBI
COLLEGE OF HEALTH SCIENCES
P O BOX 19676 Code 00202
Telegrams: varsity
Tel:(254-020) 2726300 Ext 44355

KNH-UON ERC
Email: uonknh_erc@uonbi.ac.ke
Website: http://www.erc.uonbi.ac.ke
Facebook: https://www.facebook.com/uonknh.erc
Twitter: @UONKNH_ERC https://twitter.com/UONKNH_ERC

KENYATTA NATIONAL HOSPITAL
P O BOX 20723 Code 00202
Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP, Nairobi

Ref: KNH-ERC/A/237

21st July 2020

Sylvano Katayi Inyangala
Reg. No.U56/11503/2018
Dept.of Pharmaceutics and Pharmacy Practice
School of Pharmacy
College of Health Sciences
University of Nairobi

KENYATTA NATIONAL HOSPITAL APPROVED 21 JUL 2020 KNH/UoN-ERC P.O. BOX 20723 - 00202 NAIROBI

Dear Sylvano

RESEARCH PROPOSAL – EVALUATION OF THE MANAGEMENT OF DYSLIPIDEMIAS AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS AT KENYATTA NATIONAL HOSPITAL (P57/02/2020)

This is to inform you that the KNH- UoN Ethics & Research Committee (KNH- UoN ERC) has reviewed and **approved** your above research proposal. The approval period is 21st July 2020 – 20th July 2021.

This approval is subject to compliance with the following requirements:

a. Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
b. All changes (amendments, deviations, violations etc.) are submitted for review and approval by KNH-UoN ERC before implementation.
c. Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH-UoN ERC within 72 hours of notification.
d. Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH- UoN ERC within 72 hours.
e. Clearance for export of biological specimens must be obtained from KNH- UoN ERC for each batch of shipment.
f. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal*).
g. Submission of an *executive summary* report within 90 days upon completion of the study. This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/ or plagiarism.

For more details consult the KNH- UoN ERC website **http://www.erc.uonbi.ac.ke**

Yours sincerely,

PROF. M. L. CHINDIA
SECRETARY, KNH-UoN ERC

c.c. The Principal, College of Health Sciences, UoN
The Director, CS, KNH
The Chairperson, KNH- UoN ERC
The Assistant Director, Health Information, KNH

Appendix 2 INSTITUTIONAL APPROVAL

KNH/R&P/FORM/01

KENYATTA NATIONAL HOSPITAL
P.O. Box 20723-00202 Nairobi

Tel.: 2726300/2726450/2726565
Research & Programs: Ext. 44705
Fax: 2725272
Email: knhresearch@gmail.com

Study Registration Certificate

1. Name of the Principal Investigator/Researcher
   DR. SYLVANO KATAYI INYANGALA
2. Email address: silvernkat@gmail.com Tel No. 0728619468
3. Contact person (if different from PI).....
4. Email address: ..... Tel No. .....
5. Study Title
   EVALUATION OF THE MANAGEMENT OF DYSLIPIDEMIAS AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS AT KENYATTA NATIONAL HOSPITAL (P57/02/2020)
6. Department where the study will be conducted DIABETIC AND ENDOCRINOLOGY DEPARTMENT
   (Please attach copy of Abstract)
7. Endorsed by Research Coordinator of the KNH Department where the study will be conducted.
   Name: Stanley Ngare Signature ..... Date 27/7/2020
8. Endorsed by KNH Head of Department where study will be conducted.
   Name: Stanley Ngare Signature ..... Date 27/7/2020
9. KNH UoN Ethics Research Committee approved study number P57/02/2020
   (Please attach copy of ERC approval)
10. I SYLVANO KATAYI INYANGALA. commit to submit a report of my study findings to the Department where the study will be conducted and to the Department of Research and Programs.
    Signature ..... Date 27/07/2020
11. Study Registration number (Dept/Number/Year) Medicine / 239 / 2020
    (To be completed by Research and Programs Department)
12. Research and Program Stamp .....

All studies conducted at Kenyatta National Hospital **must** be registered with the Department of Research and Programs and investigators **must commit** to share results with the hospital.

KENYATTA NATIONAL HOSPITAL 29 JUL 2020 P.O. Box 20723 - 00202 NAIROBI Research Resource Centre

Version 2: August, 2014

Appendix 3: ELIGIBILITY SCREENING FORM

Diabetic and Endocrinology Outpatient Clinic Unique Identifier: DD _____ Number: _____	
Criteria	Status
Aged >40 and <75 Years	YES { } NO { }
Aged <40 with more than ten years with diabetes	YES { } NO { }
Not Pregnant	YES { } NO { }
Not Mentally challenged	YES { } NO { }
Given Consent	YES { } NO { }
If YES to al Please proceed to the Study Questionnaire	

Appendix 4a. PARTICIPANTS INFORMATION FORM

PATTERNS AND DETERMINANTS OF DYSLIPIDEMIAS AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS AT KENYATTA NATIONAL HOSPITAL

INSTITUTION	Department of Pharmaceutics and Pharmacy Practice, School of Pharmacy, University of Nairobi. P.o. Box 30197-00400, Nairobi.
PRINCIPAL INVESTIGATOR	Sylvano Katayi Inyangala P.O Box 1040-50400 Busia, Kenya Phone Number: 0728619468
SUPERVISORS	Dr. Peter N. Karimi Dr.Arthur Mugendi Dr. C.G. Githingi
ETHICAL APPROVAL	Kenyatta National Hospital/the University of Nairobi Ethical and Research Committee, P.o. Box 20723-00100, Nairobi. Email: uonknh_erc@uonbi.ac.ke.

Introduction

My name is Sylvano Katayi. I would like to tell you about a study being conducted by the above-listed researchers. The purpose of this consent form is to give you the information you need to help you decide on whether to participate in the study. Feel free to ask any question that you may have about the purpose of the research, what happens if you participate in the study, the possible risk and benefits, your right as a volunteer, and anything else about the research or this form, if not clear. When we have answered all your questions to your satisfaction, you may decide to participate in the study or not. This process is called 'informed consent.' Once you understand and agree to be in the study, I will request you to sign your name on this form. You should follow the general principle which applies to all participants in medical research:

Your decision to participate is entirely voluntarily

You may withdraw from the study at any time without necessarily giving a reason for your withdrawal. Refusal to participate in the survey will not impinge on the services you are entitled to in this facility or other facilities. We will give you a copy of this form for your

records. This research has approval by The Kenyatta National Hospital- the University of Nairobi Ethical and Research Committee.

What is this study about?

The researchers listed above are interviewing individuals diagnosed with Diabetes Mellitus(T2DM). The purpose of the interview is to find out whether the blood lipid levels are well controlled and within the normal range, to find out the type of drugs you are using, and identify the things the patient is doing (or not doing) that may affect adequate control of lipid levels. You will be asked questions about your condition. You will also have a choice to test for your serum lipid levels. There will be approximately 200 participants in this study. We are asking for your consent to participate in this study.

What Will Happen if you decide to participate in this research study?

If you agree to participate in this study, you will be interviewed by a trained interviewer in a private area where you are comfortable with answering the questions. The interview will last approximately 2o minutes. The interview will cover topics such as medication history, biodata, and lifestyle choices. After the interview, a blood sample will be taken. We will ask for a telephone number where we can contact you if necessary. If you agree to provide your contact information, it will be used only by the people working for this study and will never be shared with others. We may be required to contact you to clarify your response when necessary.

Are there any risks, harm, or discomfort associated with this study?

Although any medical research has the potential to introduce physiological, social, emotional, and physical risks, efforts will be made to minimize the risks. One potential risk of being in the study is the loss of privacy. However, we will safeguard your privacy by keeping everything you tell us as confidential as possible. We will also use a code number to identify you in a locked file cabinet. However, no system of protecting your confidentiality can be secure, so it is still possible that someone could find out you were in this study and could access information about you. Also, answering questions in the interview may be uncomfortable for you. If there are any questions you do not want to answer, you can skip them. You have a right to refuse the interview questions asked during

the interview. It may be embarrassing for you to have the disease. We will do everything we can to ensure this is done in private.

Furthermore, all study staff and interviewers are professionals with specialized training in this interview. In case of any injury, illness, or complications related to this study, contact the study staff right away at the numbers provided at the end of this document. The study staff will treat you for minor conditions or refer you to a specialist when necessary.

Benefit

Participants of this study will benefit from advice from the Principal investigator or Research assistants on ways to control blood lipid levels. The findings of this survey will be communicated with participants' regular physicians to improve the care of the patients. Also, the results of this study will provide more scientific information for practice as well as build on the existing body of knowledge on human health and science.

Will being in the study cost you anything?

This study will cost you 30 minutes of your time.

Will you get refunded for any money spent as part of this study?

This study will not cost you money

What if you have any questions in the future?

If you have further questions or concerns about participating in this study, please call or sent a text message or email to the study staff via the contact details provided in this document at the bottom of this page.

For more information about your rights as a research participant, you may contact the Principal Investigator, my supervisors, or the KNH-UoN Ethics and Research Committee using the contact provided.

If you agree, please sign the consent declaration form

Appendix 5a: CONSENT DECLARATION FORM

Participant's Statements

I have read the consent form or had the information read to me. I have had the chance to discuss this research study with the Principal Investigator. I have had my questions answered in a language that I understand. The risk and benefits have been explained to me. I understand that my participation in this study is voluntary and that I may choose to withdraw anytime. I freely agree to participate in this research study. I understand that all efforts will be made to keep information regarding my identity confidential. By signing this consent form, I have not given any of the legal rights that I have as a participant in a research study.

I agree to participate in this study: Yes_____ No _____

Participant Printed Name: _____

Participant signature/Thumb Print_____

Investigator Statement

I the undersigned have explained to the above-named participant all the details of this research study.

_____ _____ _____/___/__

Signature of Investigator Name (Surname and Other names) YYY/MM/DD

Role in the research_____

In case of any question or concerns, feel free to contact any of the following:

Principal Investigator: Sylvano Katayi Inyangala Phone No:0728619468

Lead Supervisor: Dr. Peter Karimi Phone N:

Department of Pharmaceutical and Pharmacy Practice, School of Pharmacy. The University of Nairobi. Po Box 30197-0400 Nairobi Tel: 0728619468 email: sivernkat@gmail.com

Appendix 5b: FOMU YA AZIMIO YA RIDHAA
Kauli za mshiriki

Nimesoma fomu ya kibali au nilikuwa na habari iliyosomwa kwangu. Nimekuwa na fursa ya kujadili masomo haya ya utafiti na mchunguzi mkuu. Nimekuwa na shaka yangu kujibiwa katika lugha ambayo Ninaelewa. Hatari na faida zas zimeelezewa kwangu. Nathamini kwamba ushiriki wangu katika utafiti huu ni wa kujitolea na kwamba ninaweza kuchagua kujiondoa wakati wowote. Kwa uhuru Ninakubaliana kushiriki katika utafiti huu wa utafiti. Nathamini kwamba juhudi zote zitakuwa ni kuweka habarikuhusu utambulisho wangu siri. Kwa kupitisha fomu hii ya kibali, mimi si kupewa haki yoyote ya kisheria kwamba mimi kama mshiriki katika utafiti utafiti.

Ninakubaliana kushiriki katika utafiti huu: Yes_____ No _____

Jina chapwa la mshiriki: _____

Saini ya mshiriki/Print_____

kidole Taarifa ya mchunguzi Mimi Ukiwa umeingia nimeelezea juu ya mshiriki aliyetajwa hapo juu katika maelezo yote ya utafiti huu wa utafiti.

_____ _____ ,_____/___/____

Sahihi ya jina la mchunguzi (jina na majina mengine) YYY/MM/DD

Taarifa ya mchunguzi

Mimi Ukiwa umeingia nimeelezea juu ya mshiriki aliyetajwa hapo juu katika maelezo yote ya utafiti huu wa utafiti.

_____ _____/___/____

Sahihi ya jina la mchunguzi (jina na majina mengine) YYY/mm/DD

Appendix 6: QUESTIONNAIRE

RESEARCH TITLE: PATTERNS AND DETERMINANTS OF DYSLIPIDEMIA AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS AT KENYATTA NATIONAL HOSPITAL

Date___/____/___(YYYY/MM/DD)

Unique Identifier ☐

Part A: SOCIAL-DEMOGRAPHIC INFORMATION

Tick where appropriate

1. Sex: Male ☐ Female ☐
2. Age ____(years)
3. Weight _____(kg)
4. Height_____(M)
5. BMI_____ Kg/M^2 (BMI=Weight (Kg) ÷ Squired Height(M^2)
6. Marital Status?

1. Single 2. Married 3. Divorced 3.Widowed 4. Separated

7. Employment Status

1. Employed 2. self-employed 3. Unemployed 4.Retired

8. Highest Level of Education?

1.Informal 2. Primary 2.Secondary 4. Tertiary

9. How long have you had diabetes? _____(Year)

Part B: LIPID PARAMETERS

10. Are your Lipid levels regularly checked? 0.No 1.Yes
11. If Yes to 10 above, how often?

1. Monthly 2. every after 6-month 3. Yearly 4. Others, (Specify)

12. When was your last lipid level checked?

1. Last visit 2.Past 6-month 3.Past 1 year 4. Not sure

Part C: LIPID LOWERING DRUGS

13. Are you on any lipid-lowering therapy?

0.No 1. Yes

14. If yes, in 13, which drug(s) are you using?

CATEGORY	DRUGS	STATUS	
		(1) YES	(0) NO
Statins	Atorvastatin		
	Rosuvastatin		
	Simvastatin		
	Pravastatin		
	Lovastatin		
	Others (Specify)		
Cholesterol Absorption inhibitors	Ezetimibe		
Fibrates	Gemfibrozil		
	Fenofibrate		
	Others (specify)		
Bile acid Sequestrants	Cholestyramine		
	Colestipol		
	Colesevelam		
Nicotinic acid	Nicotinic acid		

Part D: PATIENT'S ADHERENCE TO LIPID LOWERING AGENTS MORISKY MEDICATION ADHERENCE SCALE [MMAS-8]

Tick Yes or No

15. Do you occasionally forget to take your pills?

    (0) Yes (1) No

16. People sometimes miss taking their medications for reasons other than forgetting. Thinking over the past two weeks, were there any days when you did not take your medicine for reasons other than forgetting?

    (0) Yes (1) No

17. Have you ever cut back or stopped taking your medicine without telling your clinician because you felt worse when you took it?

    (0) Yes (1) No

18. When you travel or leave home, do you sometimes forget to bring along your medicine?

    (0) Yes (1) No

19. Did you take all your medicine yesterday?

    (1) Yes (0) No

20. When you feel like your symptoms are under control, do you sometimes stop taking your medicine?

(0) Yes (1) No

21. Taking medicine every day is a real inconvenience for some people. Do you ever feel hassled about sticking to your treatment plan?

(0) Yes (1) No

22. How often do you have difficulty remembering to take all your medicine? (Circle the correct number

- Never/rarely -------(1)
- Once in a while ---- (0)
- Sometimes ------ (0)
- Usually ----------(0)
- All the time ----------(0)

Total score is { }

The patient's adherence is ……...<6 (Low) 6<8 (Medium, 8 (High)

Part E: LIFESTYLE MODIFICATION STRATEGIES AND ADHERENCE

Tick Yes or No

23. Are you on any lifestyle Modification Plan? (Dietary Modification, Weight reduction, Physical exercise)?

0. No 1. Yes

DIET

24. Are you on any dietary plan with your clinician?

0. No 1. Yes

25. If Yes, in 24 above, what type of diet plan?

A. Reduced Saturated fats? (red meat, egg yolk, cheese, butter, fried fatty foods)

0. No 1. Yes

B. Increased intake of fiber?

0. No 1. Yes

26. If Yes, in 25 above, do you practice it every day?

0. No 1. Yes

PHYSICAL ACTIVITY

27. Are you on any exercise plan?

0.No, 1. Yes,

28. If Yes, in 27 above, which of these activities/ exercises do you undertake?

1.Bicycle riding 2. Digging 3. Brisk walking for at least 20 minutes or 2 K.M. daily 4. Other activity? Specify_____

29. If Yes, in 28 above, do you do it routinely? 0. No 1. Yes,

HABITS

A. Smoking

30. Do you smoke cigarettes? 0.No, ___ 1. Yes, ___

31. If Yes to 31 above, please quantify the number of packets per day?

1.Less than Half 2Half 3. More than Half

B. Alcohol Consumption

32. Do You take alcohol? 0. No, __ 1. Yes, ___

33. If Yes to 32 above, how often?

1.Daily 2. Weekly 3.Once a year 4.Others (Specify)_____

34. Which type of alcohol do you often take?

1.Beer 2. Wine 3. Spirit 4.Local brew 5.Other (Specify)_____

Part F: COMORBIDITIES'

35. Are you receiving treatment for any other chronic condition? 0.No 1. Yes

36. If Yes to 36 above list the condition(s)

a. _____
b. _____
c. _____
d. _____

Part E: OTHER MEDICATIONS

37. Are you on any other Medication?

0. No 1.Yes

38. If Yes to 37 List the Medication(s)

a. _____
b. _____

Appendix 7: DATA ABSTRACTION FORM

UNIQUE No: DD_____

Serial number: _____

A Lipids and Medication History

Serum Lipid levels (Past Three readings)						
	1St Recorded Values (mmol/l, Date:		2nd Recorded value (mg/dl), Date:		3rd Recorded Value (mg/dl), Date:	
TC						
LDL						
TG						
HDL						
Non-HDL						
The formula for calculating LDL-c and Non-HDL-c, *Non-HDL-c =TC-HDL-c* *LDL-c = TC-HDL-c-(TGs ÷_5) in mg/dl (then convert into mmol/l)*						

Lipid-lowering Drugs						
#	Drug Name	Dose (mg)	Frequency e.g. B.D.	Description (e.g. moderate intensity)	Drug Category e.g. statins,	Period on therapy
1						
2						
3						
4						
5						
6						
7						

Summary of Lipid Levels

	Lipid Type	Descriptions	
		On target (1)	Not On target (2)
1	T.C.		
2	LDL		
3	TG		
4	HDL		
5	Non- HDL		

Appendix 8 PLAGIARISM REPORT

PATTERNS AND DETERMINANTS OF DYSLIPIDEMIAS AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS AT KENYATTA NATIONAL HOSPITAL

ORIGINALITY REPORT

13%	10%	8%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	worldwidescience.org Internet Source	1%
2	www.intechopen.com Internet Source	1%
3	academic.oup.com Internet Source	1%
4	pdfs.semanticscholar.org Internet Source	<1%
5	www.onlinejacc.org Internet Source	<1%
6	"Scientific Abstracts", Journal of General Internal Medicine, 2009 Publication	<1%
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8	www.researchsquare.com Internet Source	<1%