KNOWLEDGE AND SKILLS OF CLINICAL OFFICERS TO MANAGE PATIENTS WITH HYPERTENSION AND TYPE 2 DIABETES MELLITUS AT RURAL HEALTHCARE FACILITIES IN KISUMU COUNTY, KENYA

BY

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SCHOOL OF MEDICINE

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DECLARATION

I declare that this thesis is my original work and has not been presented to any other University or Institution for a degree or any other award.

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We confirm that the work reported in this thesis was carried out by the candidate under our supervision. This thesis has been submitted for examination with our approval as University Supervisors.

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DEDICATION

My Wife Nancy and our children; Sharon and Bruce

ABSTRACT

While cost, inadequate supplies and training remain the major barriers to manage Non-communicable diseases (NCDs) globally, the knowledge and skill of clinical officers (CO) to manage patients with hypertension and type 2 diabetes mellitus (HTN&T2DM) remain poorly understood. This study investigated knowledge and skills of COs to care for patients with HTN&T2DM in rural healthcare facilities in Kisumu County, Kenya. The study determined ability to assess risk factors, examination, investigation, treatment, follow up patients and availability and use of resources. A total number of 146 [63 female (43.2%) and 83 males (56.8%)] COs were recruited into the study. The results showed that training in both hypertension and type 2 diabetes mellitus (OR=2.525, 95% CI; 0.708-9.006, P=0.153), knowledge of predisposing risk factors to HTN&T2DM (OR=9.256; 95% CI: 3.936-21.768; *P*<0.001), complete physical examination (OR=18.111, 95 CI; 1.433-228.884, *P*=0.025), ability to identify first-line medication for treatment of HTN (OR=2.116, 95% CI; 0.968-4.628, *P*=0.060) or T2DM (OR=5.250, 95% CI; 1.376-20.036, *P*=0.015), patient follow-up (OR, 18.627; 95% CI, 3.902-88.912; *P*<0.001) and availability of guidelines for the management of hypertension (OR, 21.339; 95% CI, 8.197-55.863; *P*<0.001) and diabetes mellitus (OR, 5.443; 95% CI, 2.290-12.934; *P*<0.001), simultaneous prescription anti-hypertension medication and advice on lifestyle modification strategies (OR, 10.305; 95% CI, 1.059-100.290; *P*=0.044) were all associated with the appriopriate management of patients presenting with HTN&T2DM by clinical officers. In conclusion, COs' knowledge of predisposing risk factors, physical examination, and knowledge of first-line medication, follow up strategy and access to guidelines are key to appropriate management of patients with HTN&T2DM. The study recommends COs to be trained on risk factors, physical examination and first line medications for HTN&T2DM to improve their performance and further, provision of follow up strategy and guidelines/protocol.

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LIST OF ACRONYMS

ACE	Angiotensin Converting Enzyme Inhibitor	HDSS	Health and Demographic Surveillance System
AMPATH	Academic Model Providing Access to Healthcare	HIV&AIDs	Human Immunodeficiency Virus /Acquired Immunodeficiency Syndrome
AOP	Annual Operating Procedures	HSSF	Health Sector Service Fund
AOR	Adjusted Odds Ratio	HTN	Hypertension
ARB	Angiotensin Receptor Blocker	IDF	International Federation of Diabetes
BMI	Body Mass Index	IV	Instrumental Variable
BP	Blood Pressure	KCOC	Kenya Clinical Officers' Council
C.I	Confident Interval	KHEUS	Kenya District Health Information System
Cart	combined Anti-Retroviral Therapy	KEMRI	Kenya Medical Research Institute
CCBs	Calcium Channel Blockers	KEMSA	Kenya Medical Supplies Agency
CDs	Communicable Diseases	KHEUS	Kenya Household Expenditure and Utilization Survey
CME	Continuous Medical Education	KHSSP	Kenya Health Sector Strategic Plan
COs	Clinical officers	KIPPRA	Kenya Institute for Public Policy Research and Analysis
CPD	Continuous Professional Development	KMTC	Kenya Medical Training College
CVD	Cardiovascular Disease	LMICs	Low and Medium-Income Countries
CXR	Chest-x-ray	MDGs	Millennium Development Goals
DALYs	Disability-adjusted Life Years	mmHg	millimeter of mercury (SI Unit for mercury)
DM	Diabetes mellitus	MOH	Ministry of Health
ECG	Electrocardiogram	MOPC	Medical Outpatient Clinic
EMOC	Emergency Obstetric Care	MU-ERC	Maseno University Ethics Review Committee
EMR	Electronic Medical Record	NCDs	Non-Communicable Diseases
FP	Family planning	OJT	On Job Training
FY	Financial Year	PHC	Primary Healthcare
GDP	Gross Domestic Product	PI	Principle Investigator
GOK	Government of Kenya	T.B	Tuberculosis
HbA 1c	Glycated haemoglobin	WHO	World Health Organization.
HBM	Health Belief Model		

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CHAPTER ONE

INTRODUCTION

1.1 Non-Communicable Diseases

Non-communicable diseases (NCDs) are chronic diseases that are of long duration resulting from multiple factors that include genetic, physiological, environmental and behavioral (Baldwin and Amato 2012). The spectrum of NCDs include cardiovascular, cancer, diabetes mellitus and chronic respiratory diseases are the top causes of death globally, resulting in about 41 million (17.1%) deaths annualy (WHO 2017).

Most of these NCDs share key modifiable behavioral risk factors like tobacco use, unhealthy diet, inadequate physical activity and harmful use of alcohol. The foregoing lead to metabolic risk factors that include overweight and obesity, raised blood pressure, and raised cholesterol, and ultimately disease (WHO 2017). The economic impact of this increase in NCD epidemic will be substantial because working-age adults account for a high proportion of the NCD burden (World Health 2013c). Effective approach to decrease the NCD burden in LMIC includes a combination of community and individual interventions that are already available in these countries. They include early detection of NCDs and their diagnoses using cheap technologies, non-pharmacological and pharmacological approaches for modification of NCD risk factors and affordable medications for prevention and treatment of heart attacks and strokes, diabetes, cancer and asthma. However, due to weak health systems, there are substantive gaps in their implementation particularly in LMIC (World Health 2013c).

Competent and effective use of inadequate healthcare resources, sustainable health financing mechanisms, access to basic diagnostics and essential medicines and organized medical information and referral systems are crucial for provision of effective healthcare for people with and at risk of developing HTN&T2DM. Such care can be delivered equitably only through health systems based on primary health care (PHC) (World Health 2013c)..

The WHO Package of Essential Noncommunicable Disease Interventions (WHO PEN) for primary care in low-resource settings is a novel and action-oriented response to the challenges that affect effective healthcare delivery in LMIC. It defines a minimum set of essential NCD interventions for any country that wishes to initiate a process of universal coverage reforms to ensure that health systems contribute to health equity, social justice, community solidarity and human rights. The components that were developed and validated include protocols for clinical diagnosis and treatment, tools for risk prediction of heart attacks and strokes, guidance on minimum requirements for essential medicines and affordable technologies, standards and indicators to measure progress of implementation and impact of WHO PEN (World Health 2013c).

1.1.1 Policy on Non-Communicable Diseases

As low and middle-income countries (LMIC) begin to improve efforts to combat communicable diseases and make gains in economic growth, they are becoming vulnerable to the impact of noncommunicable diseases (NCDs) (World Health 2013c). Several international meetings, resolutions and political commitments on NCDs has taken place in the past ten years; guided by WHO and supported by advocacy efforts spearheaded by civil society globally. (World Health 2013a). The consequential actions were to formulate NCD Global Action Plan and monitoring framework that impelled several countries to develop policy documents that include strategic and action plans for NCD prevention and control. Some of the most recent global initiatives that have driven NCD prevention policy development in Kenya include: (1). Moscow declaration at the first ministerial conference on healthy lifestyles and NCD control in 2011 resolution WHA65.8 (World Health 2013a); (2). Political declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases; A/RES/66/2, 2011 (Gostin et al. 2013); (3). The WHO action plan on Non-Communicable Diseases 2008-2013, which provided global

community guidance to act in a coordinated and coherent manner; the Global Action Plan for the Prevention and Control of NCDs 2013-2020; (4). Global strategy on diet, physical activity and health; resolution WHA57.17 (World Health 2007) and (5). Global strategy to reduce the harmful use of alcohol resolution WHA63.13 (World Health 2013a). The First global ministerial conference on healthy lifestyles and NCDs control, held in Moscow in April 2011, set the stage for the UN's High-level Meeting on Non-communicable Diseases in New York and the subsequent political declaration in September 2011 (Beaglehole et al. 2011). The Moscow Declaration on NCDs, which emanated from the ministerial conference, contained a commitment from governments to develop multi-sectoral public policies that create equitable health-promoting environments (Beaglehole et al. 2011).

1.1.2 Cardiovascular diseases (CVDs)

Cardiovascular diseases (CVDs) are the leading cause of morbidity and mortality globally, accounting for about 17.3 million deaths annually, that is further likely to rise to >23.6 million in year 2030 (Laslett et al. 2012). The high prevalence of hypertension, diabetes mellitus obesity, and dyslipidemia is linked with the cardiovascular epidemic globally (Mendis et al. 2015). Nearly 61% of patients with diabetes mellitus die from some form of CVD or stroke (Benjamin et al. 2018). In addition, diabetic patients with heart disease have a worse outcome with compromised quality of life compared to non-diabetic patients with CVD (Mozaffarian et al. 2016).

In Kenya, it is estimated that 25% of all hospital admissions are due to CVD and 13% of autopsies discovered CVDs as cause of death (World Health 2017). It is the second highest cause of mortality following infectious/maternal/perinatal causes (Ogeng'o et al. 2012). Globally CVDs are costly to diagnose and manage leading to premature death among the productive age group in the society hence becoming key contributors to poverty due to catastrophic health outcome and high out-of-pocket expenditure (MOH 2018).

1.1.3 Hypertension (HTN) and Diabetes Mellitus (DM)

It is estimated that hypertension (HTN) occur in more than 50% of patients with diabetes mellitus (DM) and contributes significantly to both micro and macro vascular complications of DM (Sowers 2013; Sowers et al. 2001). The risk for cardiovascular disease (CVD) is four-fold higher in patients with both DM and HTN as compared to the normotensive non-diabetic controls (Hu et al. 2007).

Elevated blood pressure (BP)) is a powerful independent risk factor for CVD and chronic kidney disease (CKD), and when high BP is associated with DM, the risk is increased even further (Garcia-Touza and Sowers 2012). Even though debate exists concerning the most favorable target for BP reduction (Accord Study Group 2010), it remains clear that steady control of BP in patients with DM is vital for preventing and delaying both micro and macrovascular complications (American Diabetes 2011). Control of high BP in the setting of DM is strongly supported by current evidence showing the serious impact that BP has on CVD in diabetic individuals (Garcia-Touza and Sowers 2012; U. K. Prospective Diabetes Study Group 1998).

Type 2 diabetes (T2DM) is a diverse, complex multisystem disorder, with various associated comorbidities, requiring a comprehensive and individualized approach to treatment (Brunton 2016). Primarily believed to be a problem of the pancreas that led to insulin deficiency (Banting et al. 1922; Polonsky 2012), T2DM is now known to be a multisystemic disorder, impacting the pancreas, muscle tissue, liver, fat cells, kidneys, and brain, as well as various hormones and also factors like systemic inflammation, genetics, and environmental (Kahn et al. 2014).

1.1.4 The Converging Pathways in the Pathophysiology of Hypertension (HTN) and Diabetes Mellitus (DM)

Both HTN&DM share several pathophysiologic mechanisms which include oxidative stress secondary to excessive production of reactive oxygen species (ROS), inappropriate activation of renin angiotensin aldosterone system (RAAS), inflammation, impaired insulin-mediated vasodilatation, increased sympathetic nervous system (SNS) activation, dysfunctional innate and adaptive immune responses and abnormal renal handling of sodium (Sowers 2013; Sowers et al. 2011). Obesity and high visceral adiposity are key pathogenic factors for the coexistence of both DM and HTN (Sowers 2013). Chronic low-grade inflammation and oxidative stress in the adipose tissue cause increased production of angiotensinogen (AGT) and angiotensin II (Ang II), with resulting tissue RAAS activation (Boustany et al. 2004). Moreover, overexpression of AGT in the white adipose tissue results in high BP (Boustany et al. 2004). Therefore, AGT and Ang II have local as well as systemic effects on BP regulation (Boustany et al. 2004; Massiera et al. 2001). Angiotensin II exerts many of its harmful effects by activation of the Ang II type 1 receptor (AT1R) (Mehta and Griendling 2007). The activation of AT1R in non-adrenal tissues cause multiple intracellular events, that includes reduced insulin metabolic signaling, production of ROS, and proliferative and inflammatory vascular responses resulting in endothelial dysfunction, insulin resistance and HTN (Mehta and Griendling 2007). Hence, there is often an activated RAAS for the coexistent of DM and HTN.

1.1.5 Challenges Facing Management of HTN and T2DM in Kenya

With increasing global trend of NCDs, strategies of investing in the prevention, which includes community screening and building community-based models of care for disease management; are solution to successful management and control of NCDs (WHO 2015). The Kenya healthcare system is organized and structured in a hierarchical manner that begins with primary healthcare, with the lowest unit being the community units, and then transcends higher levels

of healthcare, with difficult-to-manage cases being referred to tertiary referral facilities (MOH 2015). The current structure consists of six levels, namely: 1. Community, 2. Dispensaries, 3. Health centers, 4. Primary referral facilities, 5. Secondary referral facilities and 6. Tertiary referral facilities (MOH 2015).

Shortage of healthcare workers, high cost of health care (WHO 2015), inadequate resource supplies, medication and training (Settumba et al. 2015), poor patient registration system, unstructured and lack of long-term follow up care (Maher et al. 2010) are the main challenges facing HTN&T2DM management globally. Even though there are efforts to mitigate these challenges, more is needed to strengthen healthcare system, improve human resource shortage, financing, supply of drugs as well as quality assurance and improvement on information management (Schoen et al. 2009). Many countries across the globe are adopting "Task shifting" and "Task sharing" strategy to address human resource shortage. This has been effective in many high-income countries (van de Vijver et al. 2013). A study in Kibera slum, Nairobi, Kenya showed effective management of NCDs by nurses when provided with appropriate protocols and guidelines (Some et al. 2016).

Challenges facing management of HTN&T2DM globally, Kenya included, encamps shortage of healthcare workers, high cost of healthcare (WHO 2015), inadequate resource supplies, medications and training (Settumba et al. 2015), poor patient registration system, unstructured and lack of long-term follow up care (Maher et al. 2010). Although efforts have been made towards addressing these barriers, more investment should be put on strengthening health care system, to help improve challenges of human resources, financing, drug supply and quality assurance and information management (Schoen et al. 2009).

Kenya recently enacted an NCD strategic plan 2015-2020, with emphasis on the four major NCDs: cardiovascular conditions, cancers, diabetes mellitus and chronic obstructive pulmonary diseases and their risk factors (MOH 2015). The strategic plan identified 7 barriers

to attainment of prevention and control of NCDs, among them 1. poor prioritization of prevention and control, 2. lack of prevention and control infrastructure, 3. lack of resources for public awareness health initiatives, 4. poor capture and reporting of indicators, 5. unavailability and unaffordability of quality, safe and effective basic technologies and medicines for screening, diagnosis, treatment and monitoring, 6. inadequate capacity of the health workforce, and 7. nature of the health system with minimal opportunities of integrating NCDs in well-established public health care platforms like HIV, TB, family planning, maternal and child health. (Ogola et al. 2019). Although the strategic plan outlines the objectives and implementation frameworks, with progress made in addressing some of the identified challenges, there is no evidence of the effectiveness in improving the standards of care for HTN&T2DM in rural healthcare facilities.

Early diagnosis, treatment and prompt referral of patients with HTN&T2DM are known to reduce mortality and morbidity (Singh-Franco et al. 2013). Although Kenya has developed national guidelines and protocols for management of cardiovascular diseases (MOH 2018) prevention and management strategies are similar across most developing countries. In addition, HTN&T2DM prevention and management guidelines are often designed on trials in western populations and domesticated for local use, and hence there is no assurance whether these guidelines when implemented in low and middle-income settings, Kenya included, will be useful or not. Similarly, there is no randomized trial data available for the Kenyan population and scarcity of studies investigating the precise status of the disease because of the geographical, socioeconomic, and ethnic nature a diverse country.

The Kenya national guidelines for CVD management (MOH 2018) identifies care delivery structures at levels 2-4, and include human workforce (Nurses, Clinical officers, Nutritionist, Medical Officer, Lab personnel, Radiographers, Pharmacists and Pharmaceutical Technologists), diagnostic equipment (BP Machine, Stethoscope, Weighing scale, Height

meter, Thermometer, CVD risk assessment tools, Strips for urinalysis and Glucometer, Hematology equipment and reagents, Biochemistry equipment and reagents, X-Ray and ECG machines), medications (Thiazide-like diuretic, Calcium-channel blocker, ACEI/ARB, Furosemide, Statins and Aspirin) and main services offered (Detection, Diagnosis, Initiate treatment of uncomplicated hypertension, Follow-up clinic for hypertension, Referral). Further, Kenya has national protocols for identification and management of HTN, T2DM and related complications (stroke, heart failure and renal dysfunction) in adults in primary care and levels 2-6 (MOH 2018). These protocols detail step by step procedures for management of patients presenting with HTN&T2DM and related complications. However, their availability and use by healthcare staff at rural health facilities is unknown. To address the gaps, in implementation of these interventions, Healthy Heart Africa (HHA) launched a program in Kenya, which developed and tested models of chronic desease care across healthcare facilities in Kenya. The program increased awareness and knowledge about hypertension among healthworkers and the communities (Ogola et al. 2019), updated healthcare protocols for hypertension, trained providers, and equipped them to provide screening and diagnostic services (Van Gelder et al. 2017).

1.2 Statement of the Problem

Hypertension (HTN) and type 2 diabetes mellitus (T2DM) are two major risk factors for cardiovascular disease. Modification of these risk factors has been shown to reduce cardiovascular morbidity and mortality. However, the etiology of HTN&T2DM is multifaceted and complex, with the epidemic increasing worldwide, and the low and middle-income countries bearing the highest burden. In Kenya, hypertension affects almost 1 in every 3 individuals aged 45 to 54 years and half of all adults over the age of 55 years. Kenya, like in other Countries, face multiple barriers to achieving reduced HTN&T2DM in the population,

which include high prevalence of economic imbalance, inadequate health-care facilities, and poor educational status.

Although Kenya has an NCD strategic plan 2015-2020 that outlines objectives and implementation frameworks, the strategy covers the wider spectrum of NCDs, with no clear prioritization of HTN&T2DM. Early diagnosis, treatment and prompt referral of patients with HTN&T2DM are known to reduce mortality and morbidity. The NCD strategic plan 2015-2020 identifies control of CVDs at levels 2-6 of the existing healthcare structure. However, no study has investigated levels of utilization and/or implementation of the outlined strategies by healthcare personnel in the existing structure.

Although progress has been made towards achieving the strategic plan objectives, challenges exist such as lack of prevention and control infrastructure, poor capture and reporting systems and inadequate capacity of health workforce. Healthcare levels 2 (dispensaries), 3 (health centers) and 4 (primary referral) serve a larger proportion of patients in rural communities. These facilities are managed by clinical officers (COs) trained to diagnose and treat common diseases, as well as perform routine medical and minor surgical procedures, alongside administrative duties. However, no studies have been done to assess the clinical management decisions, patient outcomes, quality of care provided and level of knowledge about diseases by this cadre of health service provider. This is further compounded by lack of clarity in competencies expected of them both in training and practice. In addition, the level of competency of COs in management of CVDs and in particular HTN and T2DM remains unknown. Therefore, this study investigated the capacity of COs to manage patients with HTN&T2DM at rural health care facilities in Kisumu County.

1.3 Justification of the Study

In Kenya, NCDs are on the rise, accounting for 33% of all deaths. A total of 106,000 mortalities were documented by 2017, 18% of which were premature deaths (WHO 2017). Previous reports showed that hypertension, diabetes mellitus, heart failure, stroke, chronic kidney disease and asthma are being diagnosed more frequently consequently increasing the burden on the healthcare system (Checkley et al. 2014). Among the NCDs, Kenya has high burden of cardio-cerebral vascular diseases (42%) and Diabetes mellitus (27%) as the major causes of mortality and morbidity (WHO 2013b). It is estimated that 12% of the population in Kenya are hypertensive, 6% have diabetes mellitus and 3-10% of all hospital admissions patients are due to heart failure (MOH 2015). In the year 2015, Kisumu County had 71,000 patients with hypertension and 3,675 with high blood glucose visiting outpatient clinics. In 2016, the number rose to 130,000 and 7,003 for hypertension and type 2 diabetes mellitus respectfully (DHIS-2, 2017). Clinical Officers (COs) are posted to levels 2 through 6 of health care, but excludes level 1 (MOH 2015). In rural healthcare facilities, COs' are the primary health care providers and are expected to diagnose HTN&T2DM early, provide health education, make prompt referrals and follow stable HTN&T2DM patients. However, the role of COs in the health-care system's structure is unclear, further compounded by lack of clarity in competencies expected of them both in training and practice (Maimela et al. 2015; Mbindyo et al. 2013). Understanding knowledge gaps and challenges affecting COs in management of HTN&T2DM at primary healthcare facilities will help improve care at community level. The results from this study will contribute new knowledge that will add vital inputs to revision of training curriculum under review as outlined in the NCD strategic plan 2015-2020. Results will also enable County governments to strengthen reverse referral system and ensure mentorship of COs in Task-shifting and Task-sharing as well as address barriers for Best Practice of HTN&T2DM management at rural health care facilities.

1.4 Objectives of the Study

1.4.1 General Objective

Determine knowledge and skills of clinical officers to manage patients with hypertension and type 2 diabetes mellitus in rural healthcare facilities in Kisumu County, western Kenya.

1.4.2 Specific Objectives

1. To evaluate clinical officers' knowledge and skill to assess risk factors, examination and investigation of patients with hypertension and type 2 diabetes mellitus in Kisumu County, Western Kenya.
2. To determine abilty of clinical officers to treat and follow-up patients with hypertension and type 2 diabetes mellitus in Kisumu County, Western Kenya.
3. To establish availability and use of resources for HTN&T2DM interventions for primary health care applicable to management of hypertension and type 2 diabetes mellitus in Kisumu County, Western Kenya.

1.4.3 Research Questions

1. What is the level of clinical officers' ability to inquire risk factors, examine and investigate patients with hypertension and type 2 diabetes mellitus in Kisumu County, Western Kenya?
2. What is the ability of clinical officers to treat and follow-up patients with hypertension and type 2 diabetes mellitus in Kisumu County, Western Kenya?
3. Which interventional tools are available to clinical officers to use in management of patients with hypertension and type 2 diabetes mellitus?

1.5 Study Limitations

1. The study only assessed clinical officers' knowledge and skills for the care of Hypertension and Type 2 diabetes mellitus, leaving other healthcare workers who are also involved in care of these patients. Investigator reviewed the findings of other studies involving other cadre that are involved in NCDs.

2. Despite having other described NCDs such as epilepsy, cancer, and asthma which burden LMIC such as Kenya, the study looked at the management of hypertension and type 2 diabetes mellitus.

1.6 Assumption

In order to conduct the study the following assumptions were made;

1. The respondents will cooperate and give honest responses to the questions in the research tools.
2. The target population will have a common understanding on the issues in the tools of data collection.

CHAPTER TWO

LITERATURE REVIEW

2.1 Non-Communicable Diseases (NCDs) – Global Perspectives

Non-communicable diseases (NCDs), that including cerebral-cardiovascular diseases, diabetes mellitus, chronic respiratory disease, acute and chronic kidney injury, mental illness, neoplasm and traumatic injuries (WHO 2017), are the principal cause of death and are responsible for 70% of deaths globally. These NCDs share key modifiable behavioral predisposing risk factors such as tobacco use, unhealthy diet, lack of physical activity, and the harmful use of alcohol, which in turn lead to obesity, raised blood pressure, and raised cholesterol, and ultimately disease. They are key public health challenge in all countries, including low- and middle-income countries where more than three-quarters of NCD deaths occur.

The first global objective is a 25% comparative decrease in overall death from the four main NCDs (cardiovascular diseases, cancers, diabetes, and chronic respiratory diseases) (World Health 2013b). Further targets relate to the reduction in NCD risk factors including behavioral risk factors (the harmful use of alcohol, physical inactivity, salt/sodium intake and tobacco use) and metabolic risk factors (raised blood pressure, raised blood glucose and obesity) (World Health 2013b). Targets were also set regarding country ability to deal with NCDs, particularly the accessibility of technologies and medicines to treat NCDs, and access to drugs and counseling to prevent heart attacks and strokes (World Health 2013b). World Health Organization is tracking worldwide steps forward on these targets. In 2016, NCDs were responsible for 71% (41 million) of the 57 million deaths which occurred globally (Hughes et al. 2011). The major NCDs that accounted for these deaths included cardiovascular diseases (17.9 million deaths, accounting for 44% of all NCD deaths and 31%

of all global deaths); cancers (9 million deaths, 9% of all NCD deaths and 16% of all global deaths); chronic respiratory diseases (3.8 million deaths, 9% of all NCD deaths and 7% of all global deaths); and diabetes (1.6 million deaths, 4% of all NCD deaths and 3% of all global deaths). Higher percentage (75%) of adult premature deaths (occurring in 30-69 years adults) was because of NCD, hence evidence that NCDs are not solely problem in older population. In 2016, probability of dying from one of the main NCDs was 18%, with the male gender having a higher risk (22%) than female (15%)(Hughes et al. 2011). In the same year, 78% of NCD death and 85% of premature death occurred in low and middle-income countries (LMICs), while adults in these countries had a higher risk (21-23%) of dying from NCD compared to same population in high-income countries (12%). There is a varied NCD mortality probability observed by WHO, with African (22%), Eastern Mediterranean (24%) and South-East Asian (23%) regions leading compared to regions of the Americas (15%), and the European (17%) and Western Pacific (16%). In all these regions, men had a higher risk than females. However the overall risk of premature death from NCDs reduced from 22% in 2000 to 18% in 2016 (Hughes et al. 2011).

2.2 National Systems Response to NCDs

The most important part of global response to NCD control and prevention is how individual states systems respond to NCD care (WHO 2013a). However, patients develop complications as they delay seeking care due to affordability and unavailability of essential supplies in healthcare facilities. Since many of the NCDs and their complications are preventable and therefore their occurrences are undesirable (WHO 2013a). The national systems response to NCD is via global objective to guarantee equity to therap, counseling and prevention of complications. This also ensure adequate availability of essential technologies and supplies both in private and public healthcare facilities (WHO 2013a).

Response of national systems to NCDs is a vital component of the global response to NCD prevention and control. Since major gaps exist in the affordability and availability of basic health technologies and essential medicines, patients often delay seeking care and develop undesired complications. Many NCDs and their complications are preventable, making their high rates unacceptable. The national systems response to NCDs is addressed through the global targets to guarantee that those eligible obtain drug therapy and counseling (including glycaemic control) to prevent heart attacks and strokes, and an 80% availability of the affordable basic technologies and essential medicines, including generics required to treat major NCDs in both public and private facilities (World Health 2013b). The 10 essential NCD medicines include aspirins, statins, angiotensin-converting enzyme inhibitors, thiazide diuretics, long-acting calcium channel blockers, beta-blockers, insulin, metformin, bronchodilators, and steroid inhalants, which are recommended at different healthcare levels in Kenya. The six basic technologies recommended include; blood pressure measurement device, weighing scales, height measuring equipment, and blood glucose and blood cholesterol measurement devices with strips, and urine strips for albumin assay.

In 2017, about a third of all countries had more than 50% of health-care facilities offering cardiovascular risk stratification for the management of patients at high risk for heart attack and stroke (WHO 2017). This was most common among countries in the European Region and in the high-income group. Just over half of all countries in 2017 reported having cardiovascular disease guidelines that were utilized in at least 50% of health facilities. These guidelines were available and utilized mostly among countries in the European Region (74% of countries) and the upper-middle-income group (65% of countries). Fewer guidelines were available and utilized in the African Region (28% of countries) and the low-income group (23% of countries) (WHO 2017).

Globally, in 2017, nearly half of all countries reported having all ten essential NCD medicines “generally available” in primary care facilities of the public health sector (WHO 2017). Technologies to measure blood pressure were availablein all countries (97%), while technologies to measure total cholesterol were the least common (in 59% of countries). Despite these figures, the majority of countries in 2017 did not have all essential NCD medicines and technologies, with only 35% of countries worldwide having all of them (WHO 2017).

2.3 Risk factors for developing NCDs

The four main NCDs share common trend of risk factors which are behavioral in nature and preventable (tobacco use, harmful use of alcohol, physical inactivity, and unhealthy diet). Without check, these behavioral risk factors result four major metabolic/physiological changes: increased BP, overweight/obesity, raised blood glucose level and raised blood lipids.

Throughout the life course, being overweight and obese is associated with multiple adverse health consequences. Obesity is linked to an increased risk of hypertension, many NCDs (such as diabetes, coronary heart disease, stroke, and cancers) and obstructive apnea osteoarthritis (Caprio et al. 2007).

Between 1975 and 2016, the prevalence of obesity nearly tripled worldwide, and continues to rise in low- and middle- income countries, although it was once considered a problem of high-income countries (Jeon et al. 2008). Obesity is largely preventable, and one of the global NCD objectives is to halt its rise (Sowers et al. 2011). In 2016, more than 1.9 biliion people aged 18 years and older were overweight and more than 650 million being obese. Children are also affected; 340 million aged 5-9 years and 40 million below 5 years were overweight or obese in 2016 (Jeon et al. 2008). Gaining excess weight in childhood and adolescence is associated with an increased likelihood of obesity, type 2diabetes, and premature death in

adult life (Caprio et al. 2007). The largest increase in obesity was seen in the Region of the Americas (29% of the population in 2016, compared with 20% in 2000) (Jeon et al. 2008).

Alcohol is safe when taken in moderation; this means an average of one to two drinks per day for men and one drink for women. Alcohol is known to cause heart diseases, cancers, liver diseases, a range of mental and behavioral disorders, other non-communicable conditions and also risk of acquiring communicable diseases such as HIV&AIDS and pneumonia (WHO 2018b). World Health Assembly in 2010, endorsed a global strategy to reduce harmful use of alcohol, hence reduce alcohol-attributable disease burden (WHO 2010b). These areas for action were also outlined in the Global NCD Action Plan, which set a global NCD target of at least 10% relative reduction in the harmful use of alcohol as appropriate, within the national context, by 2025 (WHO 2013a).

Physical inactivity is an additional driving factor for the increasing magnitude of NCDs. People who are less physically active have an increased risk of all-cause mortality, compared with those who engage in at least 30 minutes of moderate-intensity physical activity most days of the week (WHO 2010a). Additionally, physical activity decrease the risk of stroke, hypertension and depression (WHO 2010a). Recognizing these strong associations between physical activity and physical and mental health, a global aim of 10% reduction in levels of physical inactivity by 2025 was adopted by Member States at the Sixty-sixth World Health Assembly in 2013 (WHO 2013a). In 2018, WHO established a global action plan to support physical activity, to provide updated guidance to countries and promote a framework of effective and feasible policy actions to increase physical activity at all levels (WHO 2018a). Globally in 2016, 28% of all adults aged 18 years and above were less physically active; defined as not meeting the WHO recommendation to perform at least 150 minutes of moderatly-intense physical activity per week, or the equivalent (Guthold et al. 2016).

Use of diet high in salt contributes to raise blood pressure and increases the risk of heart disease and stroke (WHO 2012). To reduce the risk, the recommended daily intake of sodium is less than 2 grams of sodium or 5 grams of salt. The global NCD targets include a sodium reduction target of 30% relative reduction in mean population salt intake by 2025 (WHO 2013a). However, there is limited data on the population salt consumption (Powles et al. 2012).

Tobacco smoking and use of smokeless tobacco, is currently one of the leading global risk factors for illness and death from major NCDs, affecting both active and passive smokers Global NCD action plan target to reduce prevalence of tobacco use by 30% by the year 2013. (WHO 2013a). In 2016, 34% of men and 6% of women aged 15 years and older were active users of tobacco globally (WHO 2018c). The exact pathophysiology of cigarette smoking is clearly known; cigarette smoking causes injury to the vascular endothelium, produces superoxide anions, decreases the production and bioavailability of nitric oxide (NO), increases production of and release of endothelium, causes thrombosis, atherosclerosis, infarction, coronary artery disease, stroke and death (Rahman and Laher 2007).

2.4 Cardiovascular diseases (CVDs)

Cardiovascular diseases (CVDs) lead in mortality and morbidity globally and account for about 17.3 million death annually, and further estimated to rise to >23.6 million by year 2030 (United Nation 2012). Global CVDs epidemic is linked to the high prevalence of hypertension, obesity, diabetes and dyslipidemia, with diabetes being the major independent CVD risk factor. Both HTN&T2DM have been linked to cardiovascular events and stroke in hospitalized patients (Jowi and Mativo 2008). Further, 65% of diabetic patients die of heart disease or stroke (Smith et al. 2013). Having DM combined with CVD has a worse prognosis and compromised quality of life compared to CVD patient without DM. It is estimated that

between the year 2000 and 2030, the population of the world will increase by 37%, and so will be patients with DM, increasing by 114% (United Nation 2015).

2.5 Hypertension

Hypertension (HTN) is defined as persistently elevated, systolic and/or diastolic blood pressure (BP) of 140/90 mmHg and above in persons aged 18 years and over. The definition also applies to those individuals who are already taking antihypertensive medications even if their current blood pressure is less than 140/90 mmHg (MOH 2018). HTN is present in more than 50% of diabetic patients and contributes significantly to both micro and macrovascular disease in diabetes mellitus (DM) (Sowers et al. 2001; Sowers et al. 2011; Stamler et al. 1993). Hypertension remains a major risk factor for coronary heart disease, chronic kidney disease, and ischaemic, as well as haemorrhagic, stroke (Dzudie et al. 2018). If left uncontrolled, raised blood pressure will probably complicate heart failure, peripheral vascular disease, renal failure, retinal hemorrhage, visual impairment, stroke and dementia (Dzudie et al. 2018).

High blood pressure is the most significant risk factor for stroke (Huffman et al. 2015). It causes about 50 per cent of ischemic strokes as well as hemorrhagic stroke. The damage that hypertension causes happens over time and is often only diagnosed when considerable damage has already happened blood vessels (Huffman et al. 2015). Although, in the majority of cases, the exact cause of raised blood pressure is idiopathic, several preventable risk factors increase its likelihood, such as a high salt intake, being overweight or obese, the harmful use of alcohol, physical inactivity, stress, air pollution and smoking (Dzudie et al. 2018). The global NCD target for hypertension is a 25% reduction in the prevalence of raised blood pressure by 2025 (WHO 2013b). Hypertension usually present with tiredness, confusion, vision changes, angina-like chest pain, heart failure, blood in urine, nosebleed, irregular heartbeat, ear noise or buzzing (Huffman et al. 2015).

2.5.1 Burden of Hypertension

Globally, in 2015, 22% of the adult population 18 years of age and older had raised blood pressure – defined as systolic and/or diastolic blood pressure greater than, or equal to, 140/90 mmHg (Abarca-Gomez et al. 2017). The prevalence of high blood pressure varied across WHO regions and by country income groups. Africa had the highest prevalence (27%) America had the lowest (18%). Prevalence of elevated blood pressure in adults has reduced in high-income countries over the past few decades and now similar trend is being observed in some middle-income countries. Current trends show population of adults with elevated blood pressure have increased from 594 million in 1975, to 1.13 billion in 2015, with the increase seen majorly in low- and middle-income countries (Abarca-Gomez et al. 2017).

2.5.2 Diagnosis of HTN

Blood pressure is measured routinely at every clinical care visit (Pickering et al. 2005). At the first appointment, BP should be taken in both arms to note any disparities. Naïve patients with high blood pressure (≥140/90 mmHg) should have blood pressure taken on a later day, within 1 month of visit, to confirm the diagnosis of hypertension. Office-based semi-automated oscillometer blood pressure is the conventional technique used to diagnose hypertension and monitor treatment response. Blood pressure should be measured by a trained individual for precision (Pickering et al. 2005), in the seated position, with feet on the floor and arm supported at heart level. Cuff size should be fitting for the upper-arm circumference. To reduce within-patient inconsistency, blood pressure should be measured after 5 minutes of rest, 2 to 3 readings should be taken 1 to 2 minutes apart, and blood pressure measurements should be averaged (Powers et al. 2011). It is particularly important to make an average repeated measurement of blood pressure for the diagnosis of hypertension and titration of antihypertensive therapy towards the expected target.

2.5.3 Impact of Blood pressure control

The goal of treatment is to achieve blood pressure below 140/90mmhg as treatment of BP above this has been shown to significantly reduce risk of stroke, coronary heart disease, chronic kidney disease, heart failure and death. Change of lifestyle factors can delay onset of hypertension in normotensive, contribute to lowering of blood pressure in treated patients and in some cases abolish need for antihypertensive therapy (Martin-Timon et al. 2014).

High Blood Pressure (BP) is a strong independent risk factor for CVD and chronic kidney disease (CKD), and when HTN is associated with DM, the risk is increased even further (Garcia′Touza and Sowers 2012; Sowers et al. 2011). Although controversy exists regarding the optimal target for BP reduction (Garcia′Touza and Sowers 2012; Sowers et al. 2011), it remains clear that steady control of BP in patients with DM is crucial for preventing and delaying both micro and macrovascular complications (American Diabetes 2014; Group 1998). Reports from early landmark trials such as the United Kingdom Prospective Diabetes Study (UKPDS), Hypertension Optimal Treatment (HOT), Systolic Hypertension in the Elderly (SHEP), and Systolic Hypertension in Europe (Syst-Eur) showed that consist BP control was beneficial in hypertensive patients with diabetes.

Clinical management guidelines resulting from the widely accepted Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) and the American Diabetes Association (ADA), recommends a strict treatment of HTN in the setting of DM, aiming at values <130 mm Hg for systolic BP and <80 mm Hg diastolic BP (American Diabetes 2014). Nonetheless, the additional beneficial effects of such lower BP targets remain unknown (American Diabetes 2013; Group 2010). Hence, the recently revised ADA clinical guidelines suggest that the BP goal for people with DM and HTN should be <140/80 mmHg (American Diabetes 2013).

Recently, the results of the Action to Control Cardiovascular Risk in Diabetes (ACCORD) BP study (Group 2010), showed that in patients with DM, targeting systolic BP to <120 mm Hg did not decrease the rate of CV events (non fatal MI and death from cardiovascular causes), compared with subjects in whom the target was <140 mm Hg, except for strokes. Certainly, from current data, the optimal BP goal for diabetic patients should be individualized. Nevertheless, available literature suggests that a maximal benefit of BP control in DM patient is attained with systolic BP between 130-135 mmHg and diastolic BP of 80 to 85 mm Hg, except in stroke prevention, where data suggests that further lowering BP may be beneficial to these patients.

2.5.4 Treatment of hypertension: Pharmacological therapy

Angiotensin II converting enzyme inhibitors

Use of Ang II converting enzyme inhibitors (ACEI) reduces the activity of Ang II, which results in vasodilatation, decreased BP and improvement in the deleterious effects of Ang II on cardiac, vascular and renal tissues (Hansson et al. 1999; Rahman et al. 2005). Collectively, there is significant evidence to support RAAS blockade as the first line of therapy for HTN in DM to prevent or delay microalbuminuria; however evidence to sustain their use in normotensive diabetic patients (type 1 or 2) to prevent or delay the development of microalbuminuria is lacking. However, RAAS blockade also has potential benefits beyond BP lowering effects, including improvements in insulin resistance, inflammation, oxidative stress and vascular function (Lastra et al. 2008).

Calcium channel blockers (CCBs)

Treatment with amlodipine was associated with similar rates of coronary mortality and nonfatal MI as treatment with ACEI (lisinopril) and the diuretic chlorthalidone (Rahman et al. 2005). However, the heart failure rate was higher in those treated with CCBs as compared to

chlorthalidone, which could be in part due to lower BP achieved in the patients treated with the diuretic, or discontinuation of diuretic therapy in the CCB group patients.

Diuretics

Chlorthalidone is effective as CCBs and ACEIs in reducing cardiovascular morbidity and mortality (Rahman et al. 2005). Also thiazide-like diuretic reduced the rate of stroke, coronary heart disease, heart failure and all-cause mortality in very old hypertensive patients (Beckett et al. 2008). Although they have a significant metabolic effects in particular , they cause impaired glycemic control in diabetic patients (Cooper-DeHoff et al. 2010; Manrique et al. 2010), and worsen insulin sensitivity and glucose tolerance (Raheja et al. 2012). In high doses, diuretics can result in hypokalemia, hypomagnesemia, and hyperuricemia hence worsen glucose control in DM population (Cooper-DeHoff et al. 2010; Manrique et al. 2010).

Beta Blockers

Use of β-blockers is still controversial to date. These agents may be linked with worsen glucose intolerance and weight gain (Manrique et al. 2010; Zhou et al. 2010). Beta-blockers are generally not initial agents to treat hypertension in diabetic individuals , however, they are certainly considered in patients with coronary artery disease and heart failure (American Diabetes 2013).

Combined pharmacologic therapy

Although treatment for HTN is often initiated with a single agent, typically a majority of diabetic patients will require combination therapy to control their BP. Reseachers observed in recent study that patients who require multiple agents, fixed-dose combinations in a single tablet may improve compliance relative to use of free-drug components given separately, as it simplifies treatment and thereby improve adherence on the part of the patients (Gupta et al. 2010).

2.6 Diabetes

Diabetes mellitus is a chronic disease caused either due to failure of the pancreas to produce enough insulin (type 1 diabetes) or because the body is unable to effectively use the insulin it produces (type 2 diabetes) (Williams and Williams 2003). Insulin is a hormone that regulates blood glucose, both types of diabetes result in raised blood glucose, and over time this can cause serious damage to the body. The heart, blood vessels, eyes, kidneys and nerves are all affected, with possible complications resulting to heart attack, stroke, kidney failure, lower limb amputation, blindness and nerve damage (Williams and Williams 2003). Diabetes is therefore a serious threat to public health, and an important cause of morbidity, mortality, and increased health-system costs across the world (Williams and Williams 2003).

2.6.1 Burden of Diabetes

Globally, the number of people with diabetes has increased four-fold since 1980 from 108 million to 422 million in 2014 (Whaley-Connell et al. 2010). The Eastern Mediterranean Region showed the highest levels (14% of the population), while 7–9% of the population from other regions had high levels of blood glucose. The upper-middle-income group tended to have higher levels (9%); however, all income groups ranged between 7–9% of the population.

In Kenya the National Diabetes strategy 2010–2015 estimates diabetes prevalence at 3.3 %, with a projected rise to 4.5 %, in 2025, translating to 1.8 million Kenyans living with diabetes (Guariguata et al. 2013). Due to poverty, most diabetics even with subsidies are unable to afford health care, that include the cost of drugs, transportation and laboratory test (Azevedo and Alla 2008).

2.6.2 Diagnosis of Diabetes Mellitus

With the increase of both microvascular and macrovascular complications, glycated hemoglobin (HbA1c) has been included in screening, diagnostic criteria as well as

monitoring of diabetes (American Diabetes 2015). In 2010, ADA recommended the use of HbA1c for diagnosis of DM, and is now adopted by WHO, European Association for the Study of Diabetes as well as professional groups in United States as a diagnostic criteria for diabetes (American Diabetes 2015). It is now clear that DM can be diagnosed by use of either HbA1c >6.5% or Fasting blood glucose >126mg/dl or 2-hour glucose >200mg/dl (American Diabetes 2015). Further, for pre diabetes, individuals with fasting glucose 100-125mg/dl, 2-hour glucose of 140-199 mg/dl or HbA1c of 5.7-6.4% are at a higher risk to develop T2DM (American Diabetes 2015). In Kenya, Pastakia et al. (2013) recommended the use of HbA1c to improve care for patients with DM at Moi Teaching and Referral Hospital, Eldoret (Pastakia et al. 2013).

Since the earlier scientific reports on monitoring and management of diabetes alongside the vast microvascular and macrovascular related complications, diabetes mellitus screening and diagnosis have changed, with the inclusion of glycated hemoglobin (HbA1c) of at least 6.5% in the diagnostic criteria of type 2 diabetes mellitus (American Diabetes 2015). This alteration in criteria has recognized separate subsets of newly diagnosed patients with diabetes mellitus. However, the overall diabetes mellitus epidemic continues, with a 75% increase in the number of affected patients with diabetes mellitus across all age groups from 1988 to 2010 globally (Cheng et al. 2013).

2.6.3 Treatment of type two diabetes mellitus: Pharmacological therapy

As the first line pharmacotherapy for T2DM, metformin can change gut mucosal microbiota (Inzucchi et al. 2015), hence activates AMP-activated protein-kinase (AMPK) (Inzucchi et al. 2016). While in the liver, metformin inhibit gluconeogenesis to decrease fasting blood glucose by 20% and HbA1c by 1.5% (Song 2016).

In absence of side effect and intolerance, evidence available supports Metformin as the initial therapy alongside lifestyle modification for T2DM for its efficacy, safety, low cost and

reduction of cardiovascular events (Holman et al. 2008). When metformin fails to achieve target glucose levels, a second medicine is added, however the new added noninsulin agent will reduce HbA1c by 0.9-1.1% (Bennett et al. 2011).

Sulfonylurea derivatives act by closing pancreatic cell potassium channels, which leads to enhanced secretion of insulin (Ferrannini et al. 1987). The mode of action of sulfonylurea derivatives implies that they also act at low concentrations of plasma glucose, which may cause hypoglycemia (Ferrannini et al. 1987).

Insulin therapy is essentially reserved for poorly controlled T2DM. Although insulin acts at muscle level to reduce insulin resistant in T2DM (Bonora et al. 2008), benefit for its long term use in early stages of T2DM is unknown. In addition, insulin enhances weight gain, hypoglycemia, inability to reverse pathophysiology (Muniyappa and Quon 2007), and chronic inflammatory process in insulin resistant T2DM through up regulation of proinflammatory signals, the foregoing does not favor insulin to be initial pharmacotherapy inT2DM.

Insulin therapy is used in insulin-deficient patients who have poorly controlled type-2 diabetes. Insulin acts primarily in muscle to overcome insulin resistance, particularly when endogenous secretion of insulin is reduced (Bonora et al. 2008).However, the benefits of long-term insulin therapy in patients at very early stages of type-2 diabetes are unclear.

2.7 Hypertension and Type 2 diabetes: The Converging Pathways in the pathophysiology

Type 2 diabetes mellitus (T2DM) and hypertension (HTN) share several pathophysiologic pathways that includes; oxidative stress secondary to excessive production of reactive oxygen species (ROS), inappropriate activation of the renin-angiotensin-aldosterone system (RAAS), inflammation, impaired insulin-mediated vasodilatation, increased sympathetic nervous

system (SNS) activation, dysfunctional innate and adaptive immune responses and abnormal renal handling of sodium (Sowers et al. 2011). Excessive weight gain, obesity and increased visceral adiposity are the main adverse factors behind the coexistence of both HTN&T2DM (Sowers et al. 2011). Chronic low-grade inflammation and oxidative stress in the adipose tissue, leading to increased production of angiotensinogen (AGT) and angiotensin II (Ang II) which result to tissue RAAS activation (Boustany et al. 2004). Therefore, AGT and Ang II have local as well as systemic effects on BP regulation (Boustany et al. 2004). Angiotensin II exerts many of its adverse effects through activation of the Ang II type 1 receptor (AT1R) (Mehta and Griendling 2007). The activation of AT1R in non-adrenal tissues cause multiple intracellular events, including increased production of ROS, reduced insulin metabolic signaling, and proliferative and inflammatory vascular responses leading to endothelial dysfunction, insulin resistance and HTN (Mehta and Griendling 2007). Thus, there is often an activated RAAS in coexistent T2DM and HTN. Elevated aldosterone production and augmented signaling via the mineralocorticoid receptor (MR) are also essential events in the pathogenesis of HTN (Williams and Williams 2003). Corticosteroids may also contribute to CVD in DM patients through actions mediated in part through activation of the MR (Sowers et al. 2011).

It is well documented that adipose tissue produces a lipid-soluble factor that stimulates aldosterone production from the adrenal zona glomerulosa (Caprio et al. 2007; Whaley-Connell et al. 2010). Thus, adipose tissue contributes to systemic elevations in BP, in part, through local production of components of the RAAS. Insulin resistance and hyperinsulinemia-Insulin resistance plays an essential role in the development of both T2DM and HTN, demonstrated by the fact that about 50% of patients with hypertension manifest with systemic insulin resistance (Bonora et al. 2008; Sowers et al. 2011). Binding of insulin to its receptor (IR) triggers two key pathways: Metabolic signaling pathway mediated by

phosphatidylinositol 3-kinase (PI3K), downstream protein kinase and signaling which ultimately results in translocation of glucose transporter 4 (GLUT-4) to plasma membrane, hence leading to increased insulin-mediated glucose transport in insulin-sensitive tissue such as skeletal muscle (Muniyappa and Quon 2007). Further Insulin also signals via growth/ proliferative signaling pathway, which is mediated by mitogen-activated protein kinase (MAPK) (Bonora et al. 2008; Muniyappa and Quon 2007). By activating MAPK dependent signaling pathways, insulin stimulates secretion of vasoconstrictor mediators, such as endothelin-1 (Formoso et al. 2006; Potenza et al. 2005), as well as increased expression of PAI-1, vascular cell adhesion molecule-1 that may result to elevated blood pressure. In conditions of normal insulin sensitivity, the balance between these vasoconstrictor and vasodilatory actions favors vasodilation. In insulin-resistant states, there is often deficient insulin metabolic signaling in concert with unchecked signaling through the growth pathway (Sowers et al. 2011).

2.7.1 Burden of HTN and T2DM combined

Hypertension and diabetes commonly occur in combination with the prevalence depending on type and duration of diabetes, individual's body mass index (BMI), history of glycemic control, age, sex, race/ethnicity, and the presence of kidney disease, among other factors (Fox et al. 2015). Indeed, the risk for cardiovascular disease (CVD) is four-fold higher in patients with both T2DM and HTN (Hu et al. 2007; Stamler et al. 1993). Besides, hypertension is a strong predisposing factor for atherosclerotic cardiovascular disease (ASCVD), heart failure, and microvascular complications. The ASCVD is defined as acute coronary syndrome, myocardial infarction (MI), angina, coronary or other arterial revascularization, stroke, transient ischemic attack, or peripheral arterial disease presumed to have originated from an initial atherosclerotic lesion and is the leading cause of morbidity and mortality for individuals with diabetes and is the most significant contributor to the direct and indirect

costs of diabetes. In recent studies, data has demonstrated that antihypertensive therapy reduces ASCVD events, heart failure, and microvascular complications in people with diabetes (Brunstrom and Carlberg 2016; Thomopoulos et al. 2017). Significant benefits can be achieved when multiple risk factor can be controlled simultaneously (Gae¦de et al. 2016). It is now evident that ASCVD morbidity and mortality have significantly reduced in diabetic patients since 1990 (Rawshani et al. 2017), and is attributed to improvement in blood pressure control in these patients (Afkarian et al. 2016; Ali et al. 2013). It is important to update the assessment and treatment of both hypertensive and diabetic patients, including advances in care to combat their coexisting impact (Arauz-Pacheco et al. 2002).

2.7.2 Pharmacological Therapy for Coexisting HTN and T2DM

Collectively, there is significant evidence to support RAAS blockade as the first line of treatment for HTN in T2DM to prevent or delay microalbuminuria. However, evidence to sustain their use in normotensive diabetic patients (type 1 or 2) to prevent or delay the development of microalbuminuria is lacking. Yet, RAAS blockade also has potential benefits beyond BP lowering effects, including improvements in insulin resistance, inflammation, oxidative stress and vascular function. Further, Simplified Treatment Intervention to Control Hypertension (STITCH) trial randomized more than 2,000 patients with and without DM whose mean blood pressure was approximately 160/95 mmHg to an ACE inhibitor alone or ACE inhibitor plus thiazide-like diuretic combined pill. The study found that the proportion of patients achieving a blood pressure <140/90 mmHg at 6 months was higher in the combined intervention group (Feldman et al. 2009). Single-pill combinations may improve medication adherence (Bangalore et al. 2007).

2.7.3 Non-Pharmacologic Treatment for Hypertension and Type 2 Diabetes Mellitus

Despite significant advances over the last several decades, the management of HTN is still far from ideal, and about 50% of hypertensive patients are still not optimally controlled (Lastra et

al. 2014). The reasons underlying these disappointing results appear to be multiple and include deficiencies in both non-pharmacologic and pharmacologic management strategies (Lastra et al. 2014). Studies in the developed economies showed that although access to antihypertensive medications increased significantly from 66% in 2003 to 81% in 2007, this was not independently associated with improved BP control (Cummings et al. 2013).

Non-pharmacological lifestyle interventions, which include dietary changes, low salt diet, weight loss, increased physical activity on a regular basis, and alcohol restriction, have shown to reduce BP in several controlled studies. Lifestyle changes including individualized counseling aimed at reducing total intake of fat, consumption of saturated fat and increasing consumption of fiber and physical activity result in significant improvements in BP and reduction in the incidence of DM (Tuomilehto et al. 2001).

2.8 Organization of Healthcare Service Delivery System

Organization of the Kenya healthcare service delivery is arranged in a hierarchy structure, placing the wider primary healthcare, community unit at the base and the narrow tertiary referral facility on top (MOH 2015). The structure consist six healthcare levels commencement from level 1: community leve; level 2: Dispensaries; level 3: Health centre; level 4: primary referral facilities; level 5:Secondary referral facilities; and level 6: Tertiary referral facilities (MOH 2015). At each level, ministry of health (MOH) recommends different resource allocation to managed NCDs.

A total of 7,795 healthcare facilities are spread across the country, composed of Non-governmental organization, private, government, Faith Based Organization and international organizations. Of these, the government takes the lead in ownership with 3,956 facilities while private sector own 2,652 facilities (MOH 2015). Medicines and general supplies in government owned healthcare facilities are procured by Kenya Medical Supply Agency

(KEMSA), a government owned agency (MOH 2018) and National Hospital Insurance Fund (NHIF)is the principle healthcare insurer in Kenya.

2.8.1 Available Technologies in Kenya

The equipment expected to be founf in level 2 and 3 of healthcare systems in Kenya include BP Machines, Stethoscopes, Weighing scales, Height meters, Thermometers, CVD risk assessment tools, Strips for urinalysis, Glucometer, Hematology equipment and reagents, Biochemistry equipment and reagents, X-Ray o ECG machine. At levels 4 and 5 healthcare facicilties, all equipment found in levels 2 and 3 should be available, and additional instruments such as Echo machine for screening, Biochemistry and hematological machines, Ophthalmoscope level electrolytes, creatinine, cholesterol and lipoproteins. At levels 5 and 6, all items in found in lower levels 2-5 should be available, plus additional facilties such as Cardiac catheterization lab, Ambulatory BP, 24 hour Holter machine, Treadmill, Facilities for telemedicine, and A critical care units (MOH 2018).

2.8.2 Human Resources for Health

Human resources for health (HRH) have long been recognized as the cornerstone of the health sector to produce, deliver and manage services. The World Health Organization (WHO) defines the health workforce as "all the people engaged in actions whose primary intent is to enhance health" (WHO 2006). Inadequate staffing levels, lack of appropriate skills, poor staff attitude, low morale and weak supervision are vital factors that undermine the quality of public health services provided, especially at rural health facilities (WHO 2006). The shortage of health workers compromises service delivery and eventually health and development of a nation. Kenya health sector has small crucial health staff like doctors, nurses and diagnostic scientists. Also there are regional disparities in the distribution of the existing health workers and the hard-to-reach get disadvantaged with less staff (WHO 2006). WHO recommends at least 23 doctors, nurses and midwives per 10,000 people. This

recommendation is yet to be realized in Kenya where one doctor, 12 nurses and midwives per 10,000 people (KDHS 2010).

Health workers in Kenya are distributed at every level of health care facility according to what the level entails. Nurses, Clinical officers, Nutritionist, Medical Officer, Lab personnel, Radiographers, Pharmacists, Pharmaceutical Technologists are at level 2 and 3, Physician, Paediatrician, Echocardiographer, Radiologist Cadres, in Level 2,3,4 while Cardiologist, Pediatric Cardiologist, Perfusionists, Cardiac anaesthetists, Specialized nurses, Cardiothoracic surgeons, Clinical pharmacist, Pathologist at level 5 and 6 (MOH 2018).

2.8.3 Clinical Officers as a profession in Kenya

Clinical Officers (COs) are non-physician clinician (NPCs) professionals in Kenya trained and licensed to perform technical, administrative and medico-legal duties beside medical doctors. Clinical Officers are trained for a shorter duration (3 years) compared to medical officers who take 6 years in training. It is therefore not clear if the curriculum covers the complexity of HTN&T2DM with the 3 year of training. Recent studies comparing the availability of medical officers in rural areas showed that NPCs are first footstep solution to human resource shortage in primary healthcare facilities (Bradley and McAuliffe 2009; Cumbi et al. 2007; Dovlo 2004; Lehmann 2008; McCord et al. 2009). Dovlo in 2004, observed that middle level workers (MLWs) are healthcare providers with shorter training and limited range of practice than professionals (Dovlo 2004). Kenya has COs who are either general Registered Clinical Officers (RCOs) or specialized COs (SCOs). In 2015, there were 1,353 COs compared to 491 doctors at district level in Kenya (MOH 2015).

In Kenya's public health system, non-physician clinicians (NPCs), currently known as Clinical Officers (COs) are alternative practitioners who are trained and authorized by law to perform certain technical, administrative or medico-legal duties at the level of amedical doctor. Recent research has shown that NPCs, a form of mid-level worker, may be a viable

solution to bringing physician-type services closer to people that need them while long-term solutions to recruiting and retaining qualified health professionals especially in rural areas are sought (Bradley and McAuliffe 2009; Cumbi et al. 2007; Dovlo 2004; Lehmann 2008; McCord et al. 2009). Mid-level workers (MLWs) are healthcare providers who have received less training, have a more restricted scope of practice than professionals, and are accredited by their countries' licensing bodies (Dovlo 2004).

The Kenyan CO cadre has two subgroups; general COs (RCOs) and specialist COs (SCO, the spcialist CO these are COs who have undertaken further post diploma specialist training in a medical discipline). Clinical Officers are regulated by the Clinical Officers Council, an institution mandated under the Clinical Officers Act (CAP 260) to oversee their training, registration and licensing in Kenya. This body provides guidance on illness to be handled by COs, requirements for continuing professional development for continued registration, and issues licenses for private practice. However, the Council does not have much influence over day-to-day CO roles, which is left to the hospitals where they work.

Available literature on COs suggests that they play distinct and important roles in the day-to-day delivery of health services in Kenya (Chilopora et al. 2007; Mbindyo et al. 2009). A recent study showed that despite the presence of a clinical officer scheme of service that describes CO roles, respondents in the rural hospitals reported having not seen it. Thus, CO roles were reported on the basis of those required of them by their supervisors (English et al. 2017).

In 2014, 35 learning institutions were registered and accredited to train clinical officers in Kenya. Kenya Medical Training Colleges (KMTCs), which are government sponsored, are nineteen (19) institutions accounting for 54.3% of Clinical Officers training institutions in the country. Others include four (4) government-sponsored, seven (7) private colleges and five (5) faith-based institutions. Training is both at the degree (Bachelor of Science in Clinical

Medicine and Surgery) and diploma level in Clinical Medicine and surgery which requires them to undergo four years and three years of schooling, respectively, followed by a one-year internship.

With the literature on the complexity of hypertension and type 2 diabetes mellitus complicating cardiovascular disease, strokes and kidney diseases, it is not clear if the period of training and scope the curriculum is adequate for COs to comprehend these conditions. There is also inadequate literature on COs training needs and how comfortable they are to manage patients with NCDs specifically, HTN and T2DM in the face of high anticipation of universal health coverage currently being piloted in Kenya.

2.9 Gap in Literature

There is limited literature on assessment of Clinical Officers' competency on NCDs care. In Kenya, a study conducted by the AMPATH program at Moi Teaching and Referral Hospital showed that utilization of electronic medical registers (EMRs) and hemoglobin A1c testing greatly improved the management of patients with diabetes mellitus (Pastakia et al. 2013), and recommended their use by COs to manage patients. Although the study conducted at a tertiary hospital that may not represent operations at smaller health care facilities, AMPATH set up NCD clinics at their rural sites alongside HIV clinics. These clinics are being managed by clinical officers; however, there is no data on their competency in managing NCDs at these sites. Another study in Kibera, Nairobi, Kenya investigated the nurses' effectiveness in management of NCDs where appropriate treatment protocols were provided (Some et al. 2016). The results showed that use of clear guidelines improved management of patients with HTN&DM. However, no data exists on the COs effectiveness to manage HTN&DM when protocols are available. Further, a previous study at Nairobi Hospital observed that HTN is the leading risk factors for stroke in hospital setting (Jowi and Mativo 2008). It is however not known whether this relationship is similar at primary healthcare facilities that refer

patients to higher levels of management. In this study, we explored the ability of COs to care for patients with HTN&T2DM, with emphasis on their levels of training, ability to conduct a diagnosis, treat and follow-up patients, under limited or absent resources.

2.10 The Conceptual Framework

The conceptual framework represents a relationship between varied factors among COs able to appropriately manage HTN&T2DM. Figure 1 shows the relationships of the independent and dependent variables that were investigated in the study.

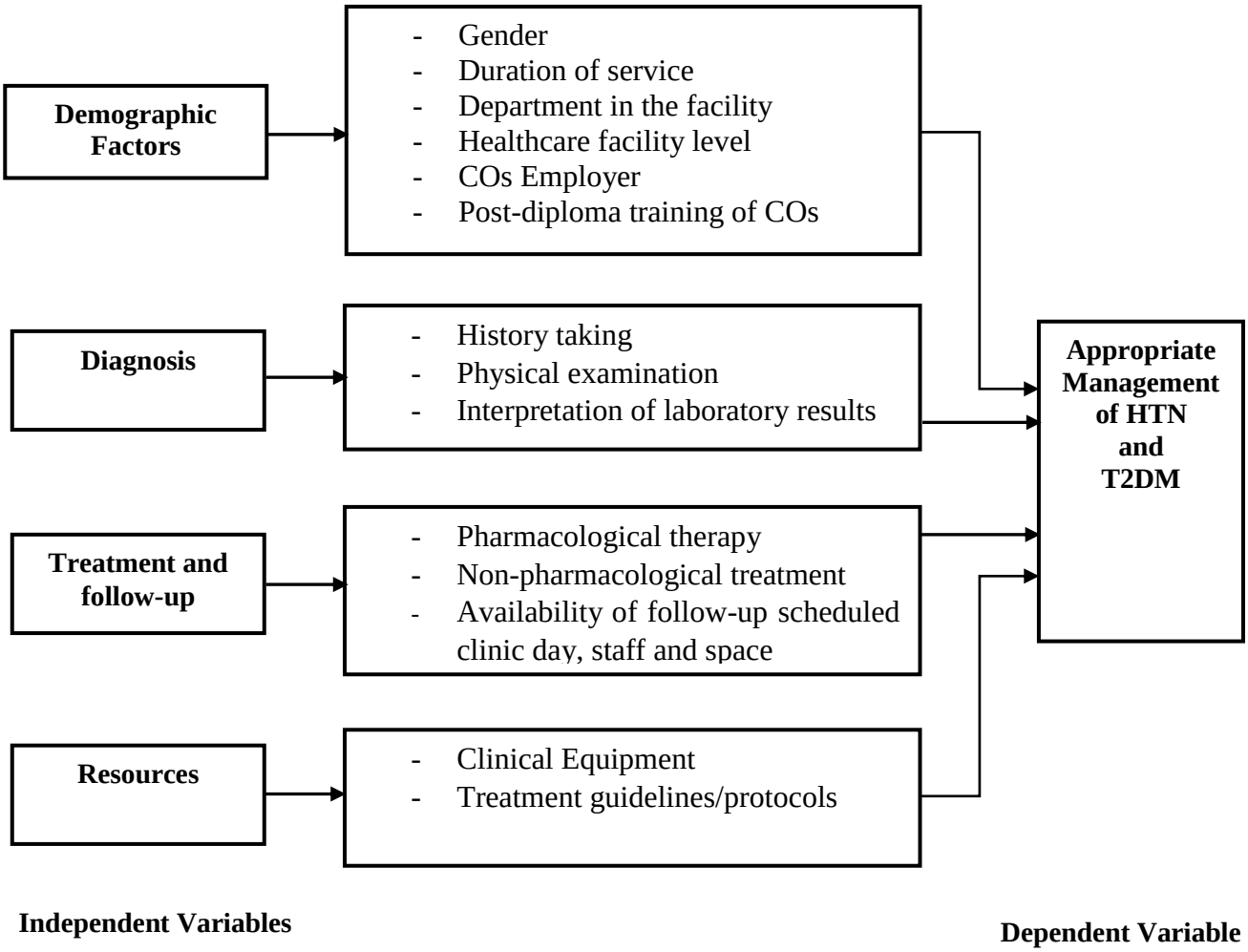

Figure 1: Conceptual framework: Abbreviations: HTN&T2DM - Hypertension and Type 2 Diabetes Mellitus; COs - Clinical Officers; CME - Continuous Medical Education

CHAPTER THREE
MATERIALS AND METHODS

3.1 Study Area

Study was conducted in rural health facilities in Kisumu County, western Kenya. Kisumu County covers an estimated area of 2,086 square km and has 6 sub-counties. It has a Total Population of 952,654 with 226,719 Households (KNBS 2013).

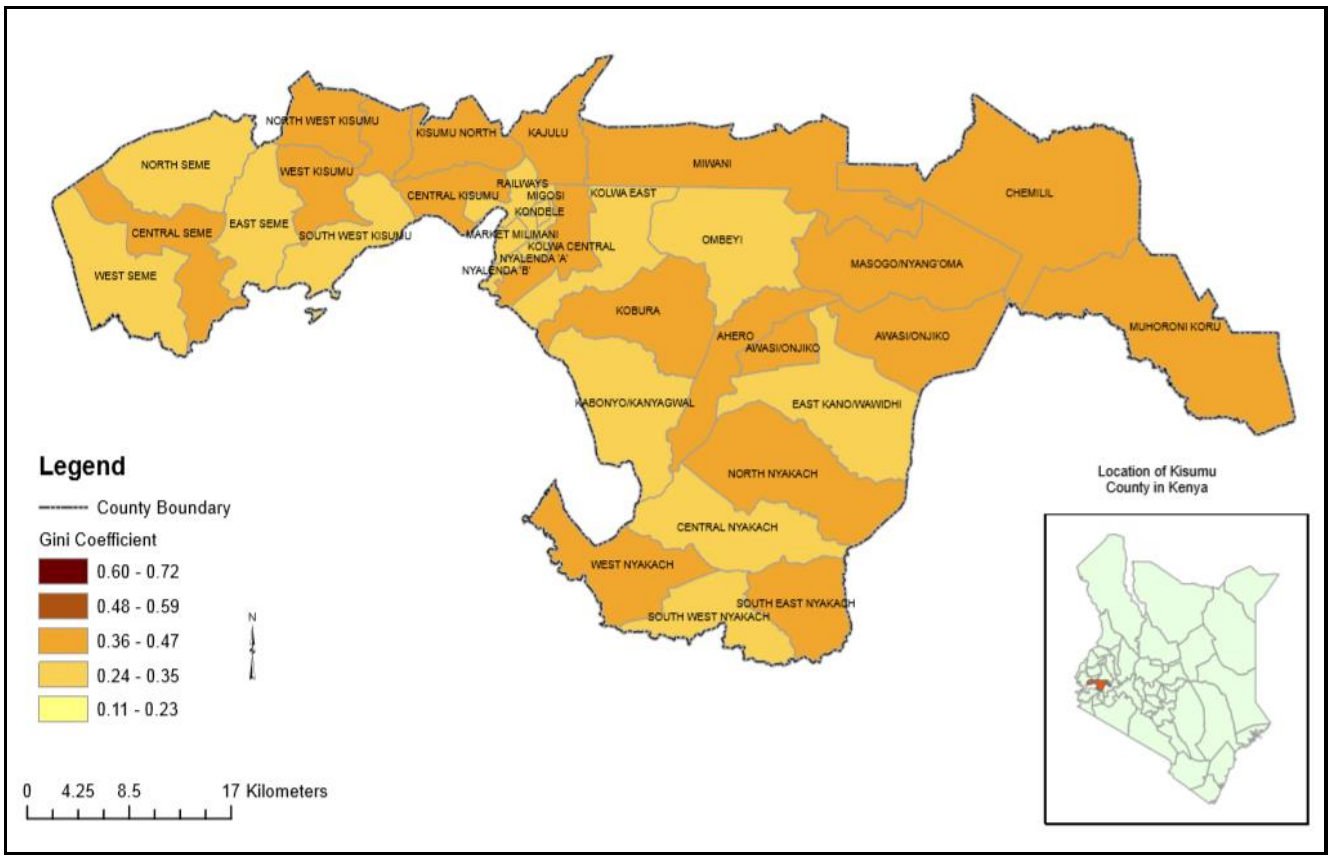

Figure 2 : Map of Kisumu County. Kenya National Bureau of Statistics 2013

3.2 Study Design

This was a cross-sectional study evaluating knowledge and skills of COs deployed in rural healthcare facilities to care for patients with hypertension and type 2 diabetes mellitus patients in Kisumu County. A list of all clinical officers in Kisumu County was obtained from county staff master list.

3.3 Study Population

The study targeted two hundred and four (204) registered clinical officers working in public rural health facilities. A population of 311 clinical officers deployed in various healthcare facilities in Kisumu County including mission and private facilities.

3.3.1 Inclusion Criteria

All registered COs working in Kisumu County rural public healthcare facility were eligible to be included in the study irrespective of their employer.

3.3.2 Exclusion Criteria

Student COs (interns) or COs on attachment (diploma levels years 2-3) were not included in the study. Non-practicing clinical officers holding administrative offices were excluded.

3.4 Determination of Sample Size

Since the target population is known, the study used Yamane (1967) formula to determine the sample size and indicated below:

$$n = \frac{N}{1 + N(e)^2}$$

Where, **N** is the target population, **n** is the sample size,**e** is the probability of error (within the desired precision of 0.05 for 95% confidence level.

Hence given the population as 311, the sample size was calculated as follows'

$$n = \frac{204}{1+204(0.05)^2} = \mathbf{135}$$

The target population of 204 realised a sample size of approximately 135.

Added 10% of the sample size for non response.

Final Sample size was calculated as follows:

135+ 13= 148

3.5 Sampling and Recruitment Procedure

3.5.1 Sampling

The study recruited registered COs in public rural healthcare facilities in Kisumu County. A master roll of all COs in public health care facilities, ranging from dispensaries to tertiary care centers were availed by the county chief officer of health (Appendix 4). The facilities were stratified by the level of service into 4 groups: Dispensaries, Health centers, Sub-county and County. The sample size was divided among the four strata depending on the percentage number of COs on the master roll in those strata. Facilities in each stratum equally shared the number of participants in that stratum.

Table 1: Proportional distribution of study participants across Health facility levels

Health Facility Level	Number of COs	Proportion of COs	Selected COs
Dispensary	47	22.6%	34
Health Centre	53	26.0%	38
Sub-County	75	37.0%	54
County	29	14.4%	22
Total	**204**	**100.0%**	**148**

3.5.2 Recruitment

Surnames of participants from each facility were written on different pieces of papers, folded and put in an envelope. Participants to be recruited were then randomly picked at that health facility by the officer (administrative non-practicing COs or Nurses) in-charge who identified them. If a participant declined to participate in the study, another name was picked at random from the remaining names in the envelope.

3.6 Study Variables and Outcomes

Hypertension and diabetes management is primarily informed by International Diabetes Federation (IDF) (IDF 2007) World Health Organisation (WHO) guidelines (WHO 2013b) and Ministry of Health guidelines. The package included a case management guide for NCD

clinicians; guidelines for nurses or paramedics to provide life style education, patients to record follow-up, drugs prescribed and instructions how to take drugs; and a training guide. All materials and intervention scoring process were used as summerised on the Communicable Disease-Health Service Delivery (COMDIS-HSD) (Huque et al. 2018). This tool has been used in implementing NCD package in primary healthcare facilities in LMIC. We were able to use the tool within the existing Kenyan guidelines. The clinical officer diagnosed patients according to the appropriate management guidelines, initiated treatment and gave lifestyle change education and finaly advised on referral and follow-up. We assessed the management of hypertension and diabetes patient using a binary indicator of whether a patient was appropriately managed during the interview. We classified a patient as appropriately managed (Huque et al. 2018) if:

1. they were diagnosed according to the procedure specified in guidelines
2. treatment was initiated with the appropriate drugs, education and counselling was provided on lifestyle behaviour change
3. if referral, as defined in the NCD desk guide and national guidelines; or if referral was not required then scheduled followup plan was initiated

3.6.1 Independent Variables

Review of WHO recommendations on country capacity to screen, treat and follow up in primary health facilities, (WHO 2013b) and previous studies in Nigeria, Pakstan, Kenya and (Abolfotouh et al. 2011; Alebiosu 2009; Some et al. 2016) and Singapore (Huque et al. 2018) showed the following independent variables were appropriate for this study: demographic (gender, duration of service, department in facility and employer, training (post diploma short course training in HTN&DM), diagnosis (history taking, physical examination, interpretation of laboratory results), treatment and follow-up (space for follow up, assigned staff,, scheduled clinic days) and resources (equipment and clinical guidelines/ protocols).

3.6.2 Dependent Variables

The primary outcome of interest was the appropriateness of COs deployed in rural health facilities to manage patients presenting with HTN&T2DM at their workstations. Therefore, COs were grouped in two strata, those who managed appropriately and those unable to manage appropriately. Using WHO (WHO 2013b) and domesticated National guidelines (MOH 2018) for management of HTN&T2DM, a score sheet of key variable outcomes (diagnosis, treatment and follow-up) was developed and used to stratify appropriate management based on output scores ranging from 0% to 100% (Appendix 5). As such, each participants score accrued from computation of key appropriate management variables which included, (i) three variables in the ability to diagnose (history taking, physical examination and interpretation of laboratory results), (ii) three variables for the ability to treat (use of first-line drugs for treatment of stable type 2 diabetes mellitus, hypertension in diabetic patient and prehypertensive patient) and (iii) follow-up of patients with HTN&T2DM. The score was averaged for each key variable and percentage calculated based on the number of test variables for each category. Any participant with a score of 50% and above was defined as able to provide appropriate management to patients with HTN&T2DM, while participants with a score below 50% were classified an inappropriate management of HTN&T2DM (Huque et al. 2018).

3.7 Data Collection Methods

3.7.1 Data Collection Tools and field procedures

Semi-structured questionnaires were administered by principal investigator to each participant at the work station alongside the observational tool. These were used to document training trends, diagnosis of HTN&T2DM, availability and use of diagnostic tools, interpretation of laboratory and radiological reports, choice of medicines and availability of management protocols for diabetes mellitus, hypertension, stroke, acute and chronic kidney

diseases. Semi-structured questionnaires were to document participant's level of education, post basic training, availability of a specified room with assigned staff, patient appointment register, specified clinic day and use of various National HTN&T2DM management protocols.

Using simulated patients with HTN&T2DM (study assistants), participants were required to demonstrate (i) inquiry of risk factors for developing HTN&T2DM, (ii) examine hypertension/diabetic patient, (iii) initiate initial treatment, (iv) advice on lifestyle change to the patient, (v) plan for follow up and referral. Further, participants were observed on the steps they used to measure blood pressure using a provided checklist.

Participants were required to physically identify the clinical equipment used to manage patients with HTN&T2DM. Therefore, COs were given clinical equipment (stethoscope, tuning fork, patella hammer, bathroom weighing scale, tape measure, blood pressure machine and glucometer) to identify. Further, the participants demonstrated the use each of these tools and showed evidence of ownership or accessibility within their examination rooms. Participants were required to present management guidelines/protocol/ treatment flow charts for hypertension, diabetes, stroke, heart failure and renal failure.

3.7.2 Validity and Reliability of Data Collection Tools

3.7.2.1 Validity of the instrument

In order to ascertain validity and reliability of the research instruments, the researcher piloted the instruments by distributing 12 questionnaires to respondents in two healthcentres in Siaya County, which is not part of the area sampled. The pilot respondents represented about 10% of the sample size. The purpose of piloting the instruments was to establish the clarity of meaning and comprehensibility of each item in the research instruments, and also to determine the time needed to complete and obtain the necessary information from them. Without altering the initial meaning, recommended revisions were done based on the

feedback received from the pilot study results and experts, which included correction of typographical errors in the questionnaire, rephrasing of questions for clarity and changes in the flow of questions. Kasomo (2014) in his study defined validity as the quality that a procedure or an instrument used in the research is accurate, correct, true, meaningful, and right (Kasomo 2014). The study applied content validity as a measure of the degree to which data to be obtained from research instruments meaningfully and accurately reflect or represent a theoretical concept. The researcher used expert judgment method to determine validity of the instruments. The researcher gave a copy of the questionnaire to the supervisor to check if it represented all the questions of the study. The study employed the use of pilot study to test the validity of the research instruments.

3.7.2.2 Reliability of the Instruments

Reliability is the consistency with which research instrument measure what it purports to measure (LoBiondo-Wood and Haber 2013). The questionnaire was tested for reliability by Cronbach coefficient alpha to determine the internal consistency of the items. This is a method of estimating reliability of test scores by the use of single administration of a test. Consequently, it provide good measures of reliability because holding other factors constant, the more similar the test content and conditions of administration are, the greater the internal consistency reliability (Shuttleworth 2010). In this study, the items were considered reliable if they yield a reliability coefficient of 0.70 and above. Research instruments are considered to be reliable when the value of the cronbach alpha is greater than 0.70 but less than 1 (Shuttleworth 2010). The reliability results for the pilot study for this study showed rliability coefficient of 0.867.

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3.7.3 Data Collection

Once authority to conduct the study was granted by the County Director of Health, an appointment with facility in-charge was scheduled before the data collection day. A structured, pilot-tested questionnaire was used to collect data. The questionnaire was formulated according to a model established during literature review and also, from related studies and the WHO PENs components that were developed and validated include protocols for clinical diagnosis and treatment, tools for risk prediction of heart attacks and strokes, guidance on minimum requirements for essential medicines and affordable technologies, standards and indicators to measure progress of implementation and impact of WHO PEN (World Health 2013c) (Modified to suit study locality inline with Kenyan guidelines from Ministry of Health).

Participants were randomly selected by officer-in-charge as described above. However, in health facilities with only one CO, interviews were conducted on those COs. A brief introduction was conducted, and the consent details explained to each participant. Once the respondents granted the consent to participate, a questionnaire was handed over to participants to read and document the demographic section that captured the following: sub-county, gender, duration of service, department s/he was deployed at the facility and the employer.

To assess the knowledge and skills COs' to diagnose HTN&T2DM, a simulated patient with HTN&DM was introduced to the participants to manage. Participants were required to probe risk factors that may have predisposed the patient to HTN&DM, measure blood pressure procedurally, measure weight, determine waist circumference and examine the patient's feet. Participants were observed in this simulated exercise and the procedure and completeness of physical examination and use of equipment document by the investigators. Further, study participants were given laboratory and radiological results and to interpret and state the

normal range for each test, such as fasting blood sugar, cholesterol levels, HbA1c, urine protein and ECG strip reads. Participants were asked how they would have managed the patient before the development of HTN&T2DM. Further, participants explained to the simulated patients how they could improve their lifestyles to prevent HTN&T2DM. Participants were thereafter required to prescribe first-line medication for HTN&T2DM to the simulated patient and provide a scheduled appointment for follow-up and appropriate referral when complications ensued.

To further access availability of resources to manage patients with HTN&T2DM, participants provided information on the availability of specific rooms dedicated for review of the patient in their health facilities, indicated if there were assigned staff to handle the patients and present a schedule chart for follow-up the patient. Besides, participants were given clinical equipment to name and present/show if s/he had similar equipment. Finally, participants were asked to present their national guideline/protocol to manage HTN&T2DM and risk prediction charts.

3.8 Data processing and analysis

3.8.1 Data processing

After completing data collection, the questionnaires were checked for completeness and accuracy. Data were entered into Microsoft Excel sheet, cleaned, coded and exported to the Statistical Package for Social Scientists (SPSS) for analysis. The database was password protected and secured on a password-protected laptop computer, which was safely stored by the principal investigator. The questionnaires containing the data were subsequently stored safely in locked cabinets by the principal investigator for any future reference.

3.8.2 Data Analysis

The present study analysis used both descriptive and inferential statistics. Chi-square χ^2 test was used to compare the distribution of test variables and logistic regression models were

used to determine the association between the variables of interest by generating the odds ratio (OR) at confidential interval (CI) of 95%. In all analyses, the set level of statistical significance was a *p*-value of less than 0.05 at 95% confidence intervals. SPSS, version 24 (IBM SPSS Inc., New York, USA) was used for the present analysis. In the study, cases were those who appropriately managed patients presenting with hypertension and type 2 diabetes mellitus. We acknowledged popular methods used to analyze binary data include the probit model, discriminant analysis, and logistic regression. In this case we used logistic regression to compare the association between the variable and the outcome. This is because many variables in regression analysis are dichotomous or discrete and logistic regression model makes no assumption about the variable distribution. It is a direct probability model because it is stated in terms of Pr{Y=1|X} and also has ability to provide valid estimates, regardless of study design (Harrell 2001). The odds ratio (OR) is a popular measure of the strength of association between exposure and outcome. In a cohort study, the odds ratio is expressed as the ratio of the number of cases to the number of non cases in the exposed and unexposed groups. The odds ratio and its familiar computation are calculated as the ratio of the products of the pairs of diagonal elements in the 2×2 table: OR=A×DB×C (Cornfield 1951). This study was guided by illustration data from Canterino et al (Elimian et al. 1999). The numerator is the odds in the intervention arm/ the denominator is the odds in the control or placebo arm = Odds Ratio (OR). So if the outcome is the same in both groups the ratio will be 1, which implies there is no difference between the two arms of the study. However: If the OR is > 1 the control is better than the intervention and if the OR is < 1 the intervention is better than the control. (Elimian et al. 1999)

Using appropriate management of HTN&T2DM as the outcome and the inquiry of risk factors, examination of the patient, investigation, treatment/prescription and follow up, availability of guidelines/protocols as exposure, an odds ratio was calculated. The

interpretation of the odds ratio is that the odds for the appropriate management of patients with HTN&T2DM by the clinical officers' exposed to good performance compared to those clinical officers who were unable to perform and inappropriately managed patients with HTN&T2DM. Point estimates for the odds ratio and confidence interval are available from Stata's cc or cs command, however, for our purposes of comparison with logistic regression, we used the Woolf option, which estimates the confidence interval using a Wald statistic which provides a simple method for estimating binomial distributions and, therefore, is widely used (Clayton and Hills 1993).

3.9 Ethical Considerations

3.9.1 Consent

The study was approved by the Maseno University Ethics Review Committee (MUERC). Permission from the county director of health and participating hospital were sought before the survey. Participants were provided with informed written consent which was voluntary and explained before signing to participate in the evaluation. Participants were free to discontinue participation at any time during the study.

3.9.2 Confidentiality and data storage

All data was coded and stored on encrypted hard drives. Hard copies remain under lock and key and only accessible to members of the research team until one year after the completion of the study, at which point the data shall be destroyed. Questionnaires excluded participants' identifiable information, such as name or personal employment number or national identity number. Data was reviewed continually throughout the study to ensure accuracy, but final data analysis was done after the completion of the entire assessment.

3.9.3 Risks and discomforts

The study was non-invasive, therefore there were minimal anticipated risks to participants; All data will be kept confidential by the PI. No participant identifiers were collected. Participation in the assessment was voluntary.

3.9.4 Potential benefits

Participants will benefit from knowing that they have participated in an assessment project that will inform efforts to improve health care and their training. The feedback on results will provide participating COs with knowledge of management of HTN&T2DM.

3.9.5 Monitoring and quality assurance

There were no anticipated adverse events from this field-based assessment. However, the PI took full responsibility for the assessment and its impact and was in daily contact with the field assessment team during the field work. If any issues developed, the assessment team immediately stopped field assessment work and contacted the PI for guidance. If there are any concerns, the PI also contacted MU-ERC for guidance.

CHAPTER FOUR
RESULTS

4.1 Introduction

This chapter describes the analysis of various variables and how Clinical officers in rural health facilities in Kisumu County can manage non-communicable diseases, specifically hypertension and type 2 diabetes mellitus.

4.2 Demographic Characteristics of Study Respondents

A total number of 146 Clinical Officers (COs) spread out in 56 public health facilities were interviewed in a study investigating healthcare workers ability to appropriately manage patients presenting with Diabetes Mellitus and Hypertension in Kisumu County. COs were stratified into those who appropriately managed (n=41) or inappropriately managed (n=105) patients with HTN&T2DM (Table 2). Results showed that 43.2% (n=63) of the respondents were female and 56.8% (n=83) were male. Assessment of the duration of service of respondents showed 75.3% (n=110) had served less than ten years, and 24.7% (n=36) served more than ten years. Most of the COs interviewed (37.0%; n=54) worked at the sub County, 26.0% (n=38) at health centers, 22.6% (n=33) at dispensary and 14.4% (n=21) at County hospitals. On departments posted, 55.5% (n=81) worked in general outpatient department (OPD), 41.8% (n=61) in HIV and 2.7% (n=4) in mother-child health (MCH) departments. The County Government employed 56.8% (n=83) of the study participants while support partners (Academic Model for Access to Health (AMPATH), Centre for Disease Control (CDC), KEMRI, Impact research Organization, safe water and Aids projects) employed 43.2% (n=63) of the respondents (Table 2). Analyses of proportions showed comparable distribution for gender (*P*=0.580), duration of service (*P*=0.572), level of hospital COs were working (*P*=0.494), the department worked in (*P*=0.572) and participants employer (*P*=0.473; Table 2).

Table 2: Respondent's Characteristics Grouped into Clinical Officers with Appropriate or Inappropriate Management of Patients with Hypertension and Diabetes

Category	Characteristics	Total (n=146)	Inappropriate management (n=105)	Appropriate management (n=41)	*P*-value
		n (%)	n (%)	n (%)	
Gender	Female	63 (43.2)	47 (44.2)	16 (39.0)	0.580
	Male	83 (56.8)	58 (55.2)	25 (61.0)	
Duration of Service	<10 years	110 (75.3)	79 (75.2)	31 (75.6)	0.572
	>10 years	36 (24.7)	26 (24.8)	10 (24.4)	
Healthcare facility Level	Dispensary	33 (22.6)	21 (20.0)	12(29.3)	0.494
	Health centre	38 (26.0)	29 (27.6)	9(22.0)	
	Sub-county	54 (37.0)	28 (36.2)	16(39.0)	
	County	21 (14.4)	17 (16.2)	4(9.8)	
Department	General OPD	81 (55.5)	54(66.7)	27(33.3)	0.572
	MCH	4 (2.7)	2(1.9)	2(4.9)	
	HIV	61 (41.8)	49 (46.7)	12(29.3)	
Employer	County Government	83 (56.8)	59 (56.2)	24 (58.5)	0.473
	Support partner	63(43.2)	46 (43.8)	17 (41.5)	

Frequency distribution of Clinical Officers (n=146) characteristics. Participants were categorized, based on the WHO guidelines and domesticated to the Kenya National guidelines on the management of hypertension and type 2 diabetes mellitus, into those with appropriate (n=41) and inappropriate management of HTN&T2DM(n=105). Data are presented as absolute number (n) and percentages (%). Statistical significance computed using the chi-square test. Abbreviations: >, greater than; <, less than; OPD, outpatient department; MCH, Mother-Child Health; HIV, Human Immunodeficiency Virus.

On post diploma training of COs, results presented showed that 43.2% (n=63) of the COs interviewed reported having completed a post-diploma training in various specialties, while 56.3% (n=83) said no additional training after graduating with a diploma in clinical medicine (Figure 4). Stratification of COs in appropriate and inappropriate management revealed that 45.7% (n=48) of respondents who had completed a post-diploma training, inappropriately managed patients with HTN&T2DM, while only 36.6% (n=15) could manage patients presented to them appropriately (Figure 3). However, the proportion distribution between comparison groups was comparable (*P*=0.317). (Fig.3)

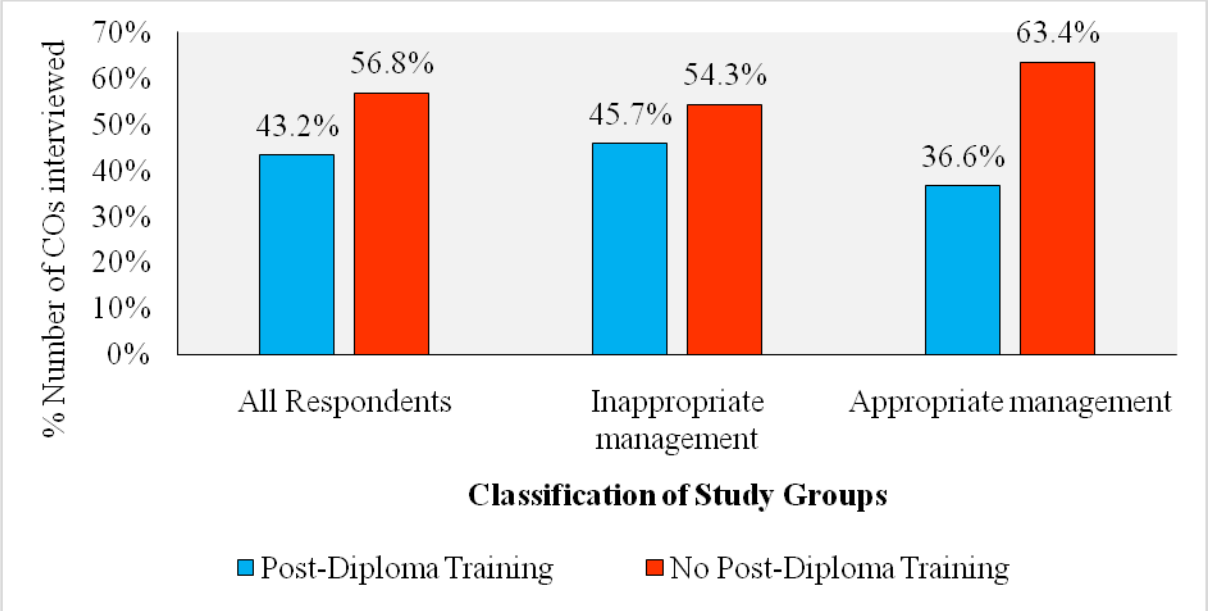

Figure 3 Post-Diploma training by Participating Clinical Officers
Clinical officers (n=146) were asked to rate the quality of teaching they received in courses related to HTN&T2DM during their diploma level training. Data presented are frequency distribution (%) of responses, stratified into those who can or cannot manage HTN&T2DM appropriately.

4.2.1 The Association between Clinical Officers' Demographic Characteristics and Appropriate Management of Hypertension and Type 2 Diabetes Mellitus

The association between demographic characteristics of COs and appropriate care of HTN&T2DM was computed using a binary logistic regression model. Results showed no statistically significant difference in management of HTN&T2DM among COs' duration of service although practice of more than 10 years showed lower odds of managing patients well. (OR=0.976, 95% CI; 0.421-2.261 *P* =0.954). Those COs working at County hospitals had higher but non-significant odds of management of patients with HTN&T2DM followed by those in Sub county hospital and health centre respectifuly (OR=2.531, 95% CI; 0.685-9.351, *P*=0.164), (OR=1.893, 95% CI; 0.544-6.586, *P*=0.316) and (OR=1.386, 95% CI; 0.366-5.210, *P*=0.634) respectively. Further analyses of the department COs served showed COs deployed in HIV department had non-significant odds of appropriate management while those in General OPD department had lower odds when compared to those deployed in MCH department; (OR=2.195, 95% CI; 0.287-16.823, *P*=0.449) and (OR=0.493, 95% CI; 0.544-

1.080, *P*=0.077), respectively (Table 3). Similarly, COs employed by county government had non-significant odds of appropriate management of HTN&T2DM relative to those employed by County government (OR=1.125, 95% CI; 0.539-2.347, *P*=0.753) (Table 3). Although having an additional training post diploma had higher odds of better management, it was not statistically significant compared with no training (OR=1.542, 95% CI; 0.724-3.285, *P*=0.262). Training in both hypertension and diabetes mellitus had increased but non-significant odds of appropriate management relative to those with no training in this conditions (OR=2.525, 95% CI; 0.708-9.006, *P*= 0.153) (Table 3).

Table 3: Association between Clinical Officers Demographic Characteristics and Appropriate Care for Hypertension and Type 2 Diabetes Mellitus patients

Category	Independent variable	Odds Ratio	95%CI	*P*-value
Duration of service post internship	<10 years	Ref.	-	-
	>10 years	0.976	0.421-2.261	0.954
Healthcare facility Level	Dispensary	Ref.	-	-
	County	2.531	0.685-9.351	0.164
	Health centre	1.386	0.366-5.210	0.634
	Sub-county	1.893	0.544-6.586	0.316
Department	MCH	Ref.	-	-
	HIV	2.195	0.287-16.823	0.449
	General OPD	0.493	0.544-1.080	0.077
Employer	Support partner	Ref.	-	-
	County	1.125	0.539-2.347	0.753
Training post diploma	Not Trained	Ref.	-	-
	Trained	1.542	0.724-3.285	0.262
Training in HTN	Not trained	Ref	-	-
	Trained	0.666	0.296-1.474	0.312
Training in DM	Not trained	Ref.	-	-
	Trained	1.249	0.527-2.955	0.614
Training in DM/HTN	Not trained in either	Ref.	-	-
	Trained in both	2.525	0.708-9.006	0.153
	Trained trained in either	1.962	0.605-6.362	0.261

Binary logistic regression analysis was performed to assess the association between demographic characteristics and clinical officers' appropriateness to manage hypertension and type 2 diabetes mellitus. Data are presented as odds ratio (OR) and 95% confidence interval (CI). Abbreviations: >, greater than; <, less than; OPD, outpatient department; MCH, Mother-Child Health; HIV, Human Immunodeficiency Virus; Ref., Reference variable.

4.3 Clinical Officers Knowledge on Diagnosis of Patients with Hypertension and Type 2 Diabetes Mellitus

Management of patients presenting with HTN&T2DM requires knowledge on the diagnosis that encompasses; (i) ability of a clinician to identify risk factors, (ii) conduct a physical examination and, (iii) interpret laboratory/radiological results (National Academies of Sciences and Medicine 2016).

4.3.1 Knowledge of Risk Factors for Developing Hypertension and Type 2 Diabetes Mellitus

Out of 146 COs interviewed, 17.8% (n=26) did not ask patients any predisposing risk factor, 11.6% (n=17) inquired only one risk factor, 28.8% (n=42) queried two risk factors, 26.7% n=39) inquired three, 13.7% (n=20) queried four and only 1.4% (n=2) documented 5 risk factors (Table 4). Further analysis showed that 41.5% (n=17) and 31.7% (n=13) of those who could identify >3 and >4 risk factors respectively were able to manage HTN&T2DM appropriately. Overall, 58.2% (n=85) of the participants were able to enquire only two or fewer risk factors. Interestingly, 78.0% (n=32) of COs who could identify ≥3 risk factors were categorized in those able to appropriately manage HTN&T2DM (*P*<0.001; Table 4).

Table 4: Clinical Officers' Ability to Inquire Risk Factors in Patients with Hypertension and Type 2 Diabetes Mellitus

Category	Characteristics	Total n (%)	Inappropriate Management n=105	Appropriate Management n=41	*P*-value
History of Risk factors	0risk factor	26 (17.8)	23 (21.9)	3 (7.3)	**<0.001**
	1risk factor	17 (11.6)	15 (14.3)	2 (4.9)	
	2risk factors	42 (28.8)	38 (36.2)	4 (9.8)	
	3risk factors	39 (26.7)	22 (21.0)	17 (41.5)	
	4risk factors	20 (13.7)	7 (6.7)	13 (31.7)	
	5risk factors	2 (1.4)	0 (0.0)	2 (4.9)	
Enquiry >3 risk factors	< 3 risk factors	85 (58.2)	76 (72.4)	9 (22.0)	**<0.001**
	≥ 3 risk factors	61 (41.8)	29 (27.6)	32 (78.0)	

Frequencies distribution of Clinical Officers' inquiry of risk factors during history taking among patients with hypertension and type 2 diabetes mellitus. Data are presented as absolute counts (n) and percentages (%). Statistical analyses computed by the chi-square test. Abbreviations: > greater than; < less than.

4.3.2 Association between Clinical Officers Ability to Inquire Risk Factors and Inappropriate Management of Hypertension and Type 2 Diabetes Mellitus

Binary regression analysis shows that Clinical officers who who inquired more than 3 risk factors among patients with hypertension and type 2 diabetes mellitus had increased odds of managing HTN&T2DM well as compared to those who inquired 3 or less risk factors, (OR=9.256; 95% CI: 3.936-21.768; *P*<0.001) (Table 5).

Table 5: Association between COs ability to inquire Risk Factors and Inappropriate Management of Hypertension and Type 2 Diabetes Mellitus

Category	Independent variable	O. R	95% CI	p-value
History taking on Risk factors	<3Risk factors	Ref.	-	-
	≥3 Risk factors	9.256	3.936-21.768	**<0.001**

Binary logistic regression analysis was performed to assess the association between history taking and inadequate care for hypertension and type 2 diabetes mellitus. The regression model controlled for the confounding effect of age between groups. Data are presented as odds ratio (OR) and 95% confidence interval (CI). Abbreviations: >, greater than; <, less than; Ref., Reference variable.

4.3.3 Physical Examination of Patients with Hypertension and Type 2 Diabetes Mellitus

Results revealed that blood pressure was measured by 62.3% (n=91) of participants interviewed, weight was taken by 61.6% (n=90), waist circumference measured by only 16.4% (n=24) COs and feet examined by 30.8% (n=45) of the respondents. However, assessment of examination completeness indicated only 4.8% (n=7) of the respondents were successful (Table 6).

Analysis of the distribution of physical examination factors between COs who could and those who could not manage HTN&T2DM appropriately, showed comparability for blood presure (*P*=0.190), weight (*P*=0.629) and feet examination (*P*=0.885). However, measurement of weight circumference differed between respondents who could appropriately

manage versus those who could not manage HTN&T2DM (*P*=0.034), with 26.8% (n=11) of COs who took the measurement able to manage HTN&T2DM appropriately. Similarly, 14.6% (n=6) of COs with complete physical examination were able to appropriately manage patients (*P*=0.001; Table 6), suggesting the importance of knowledge in the physical examination in the management of HTN&T2DM.

Table 6: Physical Examination by Clinical Officers of Patients with Hypertension and Type 2 Diabetes Mellitus

Category	Characteristics	Total n (%)	Inappropriate management n (%)	Appropriate management n (%)	*P*-value
Blood Pressure	Done	91 (62.3)	62 (59.0)	29 (70.7)	0.190
	Not done	55 (37.7)	43 (41.0)	12 (29.3)	
Weight	Taken	90 (61.6)	66 (62.9)	24 (58.5)	0.629
	Not taken	56 (38.4)	32 (37.1)	17 (41.5)	
Waist circumference	Measured	24 (16.4)	13 (12.4)	11 (26.8)	**0.034**
	Not measured	122 (83.6)	92 (87.6)	30 (73.2)	
Feet examination	Examined	45 (30.8)	32 (30.5)	13 (31.7)	0.885
	Not examined	101 (69.2)	73 (69.5)	28 (68.3)	
Exam completeness	Completed	7 (4.8)	1 (1.0)	6 (14.6)	**0.001**
	Not complete	139 (95.2)	104 (99.0)	35 (85.4)	

Frequency distribution of clinical officers' ability to take blood pressure, weight, waist circumference and examine the feet of a patient with diabetes. Data are presented as absolute number (n) and percentages (%). Statistical significance computed using the chi-square test.

4.3.4 Association between Participants Ability to Complete Physical Examination and Management of Hypertension and Type 2 Diabetes Mellitus

Results showed no statistical significant association between management of HTN&T2DM and measurement of blood pressure (OR=1.560, 95% CI; 0.652-3.732, *P*=0.318), weight measurement (OR=0.531 95% CI; 0.226-1.248, *P*=0.147), feet examination (OR=0.659, 95% CI; 0.249-1.742, *P*=0.401) and waist circumference (OR=1.613, 95% CI; 0.497-5.231, *P*=0.426). However, those who completed physical examination had increased odds of appropriate management (OR=18.111, 95 CI; 1.433-228.884, *P*=0.025) (Table 7).

Table 7: Association between Clinical Officers Ability to Complete Physical Examination and Management of HTN&T2DM

Category	Characteristic	OR	95% CI	*P*-value
Blood Pressure	Not Done	Ref.	-	-
	Done	1.560	0.652-3.732	0.318
Weight	Not Taken	Ref.	-	-
	Taken	0.531	0.226-1.248	0.147
Waist Circumference	Not Measured	Ref.	-	-
	Measure	1.613	0.497-5.231	0.426
Feet Examination	Not Examined	Ref.	-	-
	Examined	0.659	0.249-1.742	0.401
Exam Completeness	Not Completed	Ref.	-	-
	Completed	18.111	1.433-228.884	**0.025**

Binary logistic regression analysis was performed to assess the association is completing a physical examination of a patient with hypertension and type 2 diabetes mellitus and the management of hypertension and type 2 diabetes mellitus. The regression model controlled for the confounding effect of age between groups. Data are presented as odds ratio (OR) and 95% confidence interval (CI). Abbreviations: Ref., Reference variable.

4.3.5 Determination of Target Ranges for Body Mass Index in Patients with Hypertension and Type 2 Diabetes Mellitus

Study participants were asked to calculate the Body Mass Index (BMI) for their patients and determine optimum BMI targets. Of the respondents interviewed, 30.8% (n=45) calculated the BMI correctly, 39.7 (n=58) indicated the wrong formula for calculation of BMI and 29.5% (n=43) were not sure. Further, 52.1% (n=76) provided corrected BMI optimal targets, 29.5% (n=43) stated wrong targets while 18.5% (n=27) were not sure. Categorization of participants into those able or not able to manage appropriately patients with HTN&T2DM showed no statistical difference in the distribution of ability to calculate BMI (*P*=0.572), while there were marginal variations in BMI optimum targets, although it did not reach significance (*P*=0.090) (Table 8).

Table 8: Calculation and target ranges for Body Mass Index (BMI) by clinical officers for patients with hypertension and type 2 diabetes mellitus

Category	Characteristics	Total n (%)	Inappropriate management	Appropriate management	*P*-value
BMI calculation	Correct formula	45 (30.8)	30 (28.6)	15 (36.6)	0.572
	Not sure	43 (29.5)	33 (31.4)	10 (24.4)	
	Wrong formula	58 (39.7)	42 (40.0)	16 (39.0)	
BMI optimum targets	Correct values	76 (52.1)	51 (48.6)	25 (61.0)	0.090
	Not sure	27 (18.5)	24 (22.9)	3 (7.3)	
	Wrong values	43 (29.5)	30 (28.6)	13 (31.7)	

Frequency distribution of calculation of BMI and Optimal BMI targets for patients with hypertension and type 2 diabetes mellitus. Data are presented as absolute number (n) and percentages (%). Statistical significance computed using the chi-square test. Abbreviations: BMI, Body Mass Index.

4.3.6 Association between Participants Ability to Calculate BMI and Determine Optimum Targets and Management of Hypertension and Type 2 Diabetes Mellitus

Binary logistic regression analysis to determine the relationship between ability to manage HTN&T2DM appropriately and calculation of BMI showed higher odds of appropriate with statistically significant association for COs who provided a correct BMI formula (OR, 2.626; 95% CI, 0.634-4.175; *P*=0.040) (Table 9). Although those who were not sure demonstrated increased odd of appropriate management compared to those who used a wrong formula but not statistically significant. In addition, although there was no association between management of HTN&T2DM and provision of wrong target BMI values (OR, 1.025; 95% CI, 0.447-2.350; *P*=0.953), participants who provided correct optimum BMI target value and those who were not sure of the target BMI values demonstrated higher odds of appropriately managing patients with HTN&T2DM (OR= 4.346, 95% CI; 10176-16.059, *P*=0.028) and (OR, 4.246; 95% CI, 1.033-17.408; *P*=0.045), relative to COs who provided wrong BMI targets (Table 9).

Table 9: Association between Clinical Officers' ability to calculate BMI and Optimum BMI targets and management of Hypertension and type 2 Diabetes Mellitus

Category	Independent variable	O. R	95% CI	*P*-value
Ability to calculate BMI	Wrong formula	Ref.	-	-
	Not sure	1.200	0.475-3.026	0.700
	Correct formula	2.626	0.634-4.175	**0.040**
Target BMI values	Wrong value	Ref.	-	-
	Not sure of the value	4.246	1.033-17.408	**0.045**
	Optimum value	4.346	1.176-16.059	**0.028**

Binary logistic regression analysis was performed to assess the association between clinical officers' ability to calculate BMI and Optimal targets and management of patients with hypertension and type 2 diabetes mellitus. The regression model controlled for the confounding effect of age between groups. Data are presented as odds ratio (OR) and 95% confidence interval (CI). Abbreviations: BMI, Body Mass Index; Ref., Reference variable.

4.3.7 Steps Followed by Clinical Officers to Measure Blood Pressure in Patients with Hypertension and Type 2 Diabetes Mellitus

The procedure used to measure patients' blood pressure was observed and documented among participating COs (Table 10). The results showed that 68.5% (n=100) of the COs interviewed allowed the patient rest for at least 5 minutes, 82.9% (n=121) placed armrest at heart level, 84.2% (n=123) applied a cuff on the skin, 78.1% (n=114) adjusted cuff fit at least 80%, cuff was deflated to zero by 80.0% (n=118) of the respondents, 74.7% (n=109) took BP by auscultation and only 21.9% (n=32) repeated the BP measurement for confirmation. Comparison of procedures for measurement of BP between participants able or not able to manage HTN&T2DM showed variability for those who allowed patients rest for at least 5 minutes (P=0.044), but comparable for armrest at heart level (P=0.333), cuff applied on the skin (P=0.199), cuff fit at 80% (P=0.652), cuff deflated to zero (P=0.949), BP taken by auscultation (P=0.796) and BP repeated to confirm (P=0.180) (Table 10).

Table 10: Steps followed by Clinical Officers to measure blood pressure in patients with Hypertension and type 2 diabetes mellitus

Category	Characteristic	Total n (%)	Inappropriate management n=105	appropriate management n=41	*P*-value
Patient rest at least 5 minutes	Rested	100 (68.5)	77 (73.3)	23 (56.1)	**0.044**
	Not rested	46 (31.5)	28 (26.7)	18 (43.9)	
Armrest at heart level	Armrest	121 (82.9)	89 (84.8)	32 (78.0)	0.333
	Arm hanging	25 (17.1)	16 (15.2)	9 (22.0)	
Cuff applied on the skin	Applied to skin	123 (84.2)	91 (86.7)	32 (78.0)	0.199
	Applied on cloth	23 (15.3)	14 (13.3)	9 (22.0)	
Cuff fit at least 80%	Fitting cuff	114 (78.1)	83 (79.0)	31 (75.6)	0.652
	Cuff not fitting	32 (21.9)	22 (15.1)	10 (6.8)	
Cuff deflated to Zero	Cuff at zero	118 (80.0)	85 (81.0)	33 (80.5)	0.949
	Cuff not at zero	28 (19.2)	20 (19.0)	8 (19.5)	
BP taken by auscultation	Auscultated	109 (74.7)	79 (75.2)	30 (73.2)	0.796
	Not auscultated	37 (25.3)	26 (24.8)	11 (26.8)	
BP repeated to confirm	BP repeated	32 (21.9)	20 (19.0)	12 (29.3)	0.180
	BP not repeated	114 (78.1)	85 (81.0)	29 (70.7)	

Frequency distribution of clinical officers' knowledge of the procedures for taking the blood pressure of patients with hypertension and type 2 diabetes mellitus, Data are presented as absolute number (n) and percentages (%). Statistical significance computed using the chi-square test. Abbreviations; BP, Blood Pressure

4.3.8 Association between Measurement of Blood Pressure and Clinical Officers Management of Patients with Hypertension and Type 2 Diabetes Mellitus

Binary logistic regression was performed to determine the association between steps followed by COS to measure blood pressure and how they managed patients with HTN&T2DM. Analysis showed those that allowed patients to rest at least 5 minutes had higher odds of appropriate management (OR, 2.141; 95% CI, 0.970-4.726; *P*=0.059), but no relationship between management of HTN&T2DM and resting the arm at heart level (OR, 0.620; 95% CI, 0.248-1.552; *P*=0.307), applying cuff directly on the skin (OR, 0.552; 95% CI, 0.218-1.400; *P*=0.211), using cuff that fit at least 80% of the patient's upper arm (OR, 0.820; 95% CI, 0.349-1.928; *P*=0.649), cuff deflated at zero (OR, 0.951; 95% CI, 0.380-2.379; *P*=0.915), BP taken by auscultation (OR, 0.805; 95% CI, 0380-2.379; *P*=0.625) and repetition of BP to confirm (OR, 1.785; 95% CI, 0.775-1.924; *P*=0.173) (Table 11).

Table 11: Association between steps followed to measure blood pressure and Management of patients with Hypertension and type 2 Diabetes Mellitus

Category	Independent variable	Odds Ratio	95% CI	*P*-value
Patient rest at least 5 minutes	Not Rested	Ref.	-	-
	Rested	2.141	0.970-4.726	**0.059**
Armrest at heart level	Arm hanging	Ref.	-	-
	Arm rested	0.620	0.248-1.552	0.307
Cuff applied on the skin	Applied on cloth	Ref.	-	-
	Applied to skin	0.552	0.218-1.400	0.211
Cuff fit at least 80%	Cuff not Fitting	Ref.	-	-
	Cuff fitting	0.820	0.349-1.928	0.649
Cuff deflated to Zero	Cuff not at zero	Ref.	-	-
	Cuff at zero	0.951	0.380-2.379	0.915
BP taken by auscultation	Not Auscultated	Ref.	-	-
	Auscultated	0.805	0.337-1.924	0.625
BP repeated to confirm	BP not repeated	Ref.	-	-
	BP repeated	1.784	0.775-4.105	0.173

Binary logistic regression analysis was performed to assess the association between clinical officers' ability to accurately measure Blood Pressure and management of hypertension and type 2 diabetes mellitus. The regression model controlled for the confounding effect of age between groups. Data are presented as odds ratio (OR) and 95% confidence interval (CI). Abbreviations: BP, Blood Pressure; Ref., Reference variable.

4.3.9 Interpretation of Laboratory and Radiological Results of Patients with Hypertension and Type 2 Diabetes Mellitus

All 146 respondents were asked to interpret and document the optimal normal result for diabetes mellitus and hypertension on various tests. Overall, 53.4% (n=78) indicated the correct fasting glucose level and 27.4% (n=40) stated the right two-hourly postprandial glucose level. Only 8.2% (n=12) reported correct glycated hemoglobin levels (Table 12). Further, urine analysis was correctly interpreted by 17.1% (n=25) of clinical officers interviewed, 5.4% (n=8) were able to correctly interpret ranges for normal serum Cholesterol levels. Chest X-ray results were interpreted by 13.7% (n=20) COs while no participant would interpret the Electrocardiograph strip results (Table 12).

When stratified into COs who appropriately and inappropriately managed HTN&T2DM, results showed 43.9% (n=18) fasting glucose, 34.1% (n=14) prandial glucose, 7.3% (n=3),

14.6% (n=6), 4.9% (n=2) and only 9.8% (n=4) chest X-ray identified correct results. Overall, 15.1% (n=22) COs were able to interpret three out of seven laboratory results, with only 2.7% (n=4) able to interpret four out of seven results (Table 12).

Table 12: Interpretation of Laboratory and Radiological results for Hypertension and Type 2 Diabetes Mellitus and their related complications

Category	Characteristic	Total n (%)	Inappropriate management n=105	Appropriate management n=41
Fasting glucose	Not sure	6 (4.1)	4 (3.8)	2 (4.9)
	Correct	78 (53.4)	60 (57.1)	18 (43.9)
	Wrong	62 (42.5)	41 (39.0)	21 (51.2)
Two hourly postprandial glucose	Not sure	53 (36.3)	41 (39.0)	12 (29.3)
	Correct	40 (27.4)	26 (24.8)	14 (34.1)
	Wrong	53 (36.3)	38 (36.2)	15 (36.6)
GlycatedHemoglobin-A-1C(HB1AC)	Not sure	103 (70.5)	72 (68.6)	31 (75.6)
	Correct	12 (8.2)	9 (8.6)	3 (7.3)
	Wrong	31 (21.2)	24 (22.9)	7 (17.1)
Urine analysis	Not sure	99 (67.8)	68 (64.8)	31 (75.6)
	Correct	25 (17.1)	19 (18.1)	6 (14.6)
	Wrong	22 (15.1)	18 (17.1)	4 (9.8)
Cholesterol	Not sure	135 (92.5)	97 (92.4)	38 (92.7)
	Correct	8 (5.4)	6 (5.7)	2 (4.9)
	Wrong	3 (2.1)	2 (1.9)	1 (2.4)
Chest X-ray	Not sure	102 (69.9)	70 (66.7)	32 (78.0)
	Correct	20 (13.7)	16 (15.2)	4 (9.8)
	Wrong	24 (16.4)	19 (18.1)	5 (12.2)
ECG	Not sure	137 (93.8)	100 (95.2)	37 (90.2)
	Correct	0 (0)	0 (0.0)	0 (0.0)
	Wrong	9 (6.2)	5 (4.8)	4 (9.8)
Ability to interpret 3 out of 7 results	Able to interpret	22 (15.1)	15 (14.3)	7 (17.1)
	Unable to interpret	124 (84.9)	90 (85.7)	34 (82.9)
Ability to interpret 4 out of 7 results	Able to interpret	4 (2.7)	2 (1.9)	2 (4.9)
	Unable to interpret	142 (97.3)	103 (98.1)	39 (95.1)

Frequency distribution of laboratory and radiological test results for interpretation of fasting blood glucose, 2-hourly postprandial glucose, urinalysis, blood cholesterol levels, Chest x-ray and ECG. Data are presented as absolute counts (n) and percentages. Abbreviations: ECG, Electrocardiograph; HBA1c, Glycated Hemoglobin A-1c.

4.3.10 Association between Clinical Officers Ability to Interpret Laboratory and Radiological Results and Manage Hypertension and Type 2 Diabetes Mellitus

Binary logistic regression analysis showed significant relationship between appropriate management of patients with HTN&T2DM and ability to interprete 3 out of 7 results (OR=1.279, 95% CI; 0.489-8.432, *P*=0.015) or 4 out of 7 (OR=2.543, 95% CI; 0.344-18.795, *P*=0.036) when compared to those who were unable to interprete (Table 13).

Table 13: Association between Clinical Officers Ability to Interpret Laboratory Results and Management of Hypertension and Type 2 Diabetes Mellitus

Category	Characteristic	OR	95% CI	*P*-value
Fasting glucose	Wrong	Ref.	-	-
	Not sure	0.602	0.282-1.284	0.574
	Correct	1.037	0.196-5.472	**0.048**
Two hourly postprandial glucose	Wrong	Ref.	-	-
	Not sure	1.952	0.771-4.942	0.158
	Correct	1.590	0.612-4.129	0.341
GlycatedHemoglobin-A-1$_C$(HB1A$_C$)	Wrong	Ref.	-	-
	Not sure	0.689	0.169-2.807	0.604
	Correct	1.049	0.218-5.041	0.952
Urine protein analysis	Wrong	Ref.	-	-
	Not sure	0.736	0.264-2.051	0.558
	Correct	1.631	0.378-7.041	0.512
Cholesterol	Wrong	Ref.	-	-
	Not sure	0.758	0.142-4.053	0.746
	Correct	0.667	0.037-11.936	0.783
Chest X-ray	Wrong	Ref.	-	-
	Not sure	0.536	0.165-1.738	0.299
	Correct	0.968	0.221-4.236	0.965
Ability to interpret 3 out of 7 results	Unable to interpret	Ref.	-	-
	Anable to interpret	1.279	0.489-8.432	**0.015**
Ability to interpret 4 out of 7 results	Unable to interpret	Ref.	-	-
	Able to interpret	2.543	0.344-18.795	**0.036**

Binary logistic regression analysis was performed to assess the association between ability of clinical officers to interpret laboratory and radiological results and management of hypertension and type 2 diabetes mellitus. The regression model controlled for the confounding effect of age between groups. Data are presented as odds ratio (OR) and 95% confidence interval (CI). Abbreviations: Ref., Reference variable.

4.4 Treatment and Follow-up of Patients Presenting with Hypertension and Type 2 Diabetes Mellitus

Once diagnosed with HTN&T2DM, patients remain on life-long medication that dictates continuous treatment and patient follow-ups. The knowledge of first-line medication used to manage the complications of hypertension and type 2 diabetes mellitus among patients diagnosed with HTN&T2DM was investigated. Further, study participants were asked to provide patient follow-up strategies they employed at their respective health facilities.

4.4.1 Prescriptions of First Line Medicines Recommended by Clinical Officers for Patients Diagnosed with Hypertension in Diabetes Mellitus

Choice of medicines prescribed by clinical officers for the management of hypertension in patients with diabetes was assessed (Figure 4). Results showed that 23.3% (n=34) of all participants prescribed Calcium Channel Blockers (CCB), 24.0% (n=35) diuretics and 26.0% (n=38) prescribed Angiotensin Converting Enzyme Inhibitors (ACEI). Overall, 9.6% (n=14) of the participants were not sure what medications to administer to patients (Figure 4). For COs who were unable to manage patients with HTN&T2DM, 27.6% (n=29) prescibed CCB, and 22.9% (n=24) prescribed diuretics. An additional 21.9% (n=23) mentioned ACEI, the correct drug used to manage patients with hypertension. Further analysis of COs able to manage patients presenting with HTN&T2DM revealed that 36.6% (n=15) prescribed ACEI, 26.8% (n=11) diuretics and 12.2% (n=5) each gave CCB or a combination of ACEI and diuretics, respectively (Figure 4).

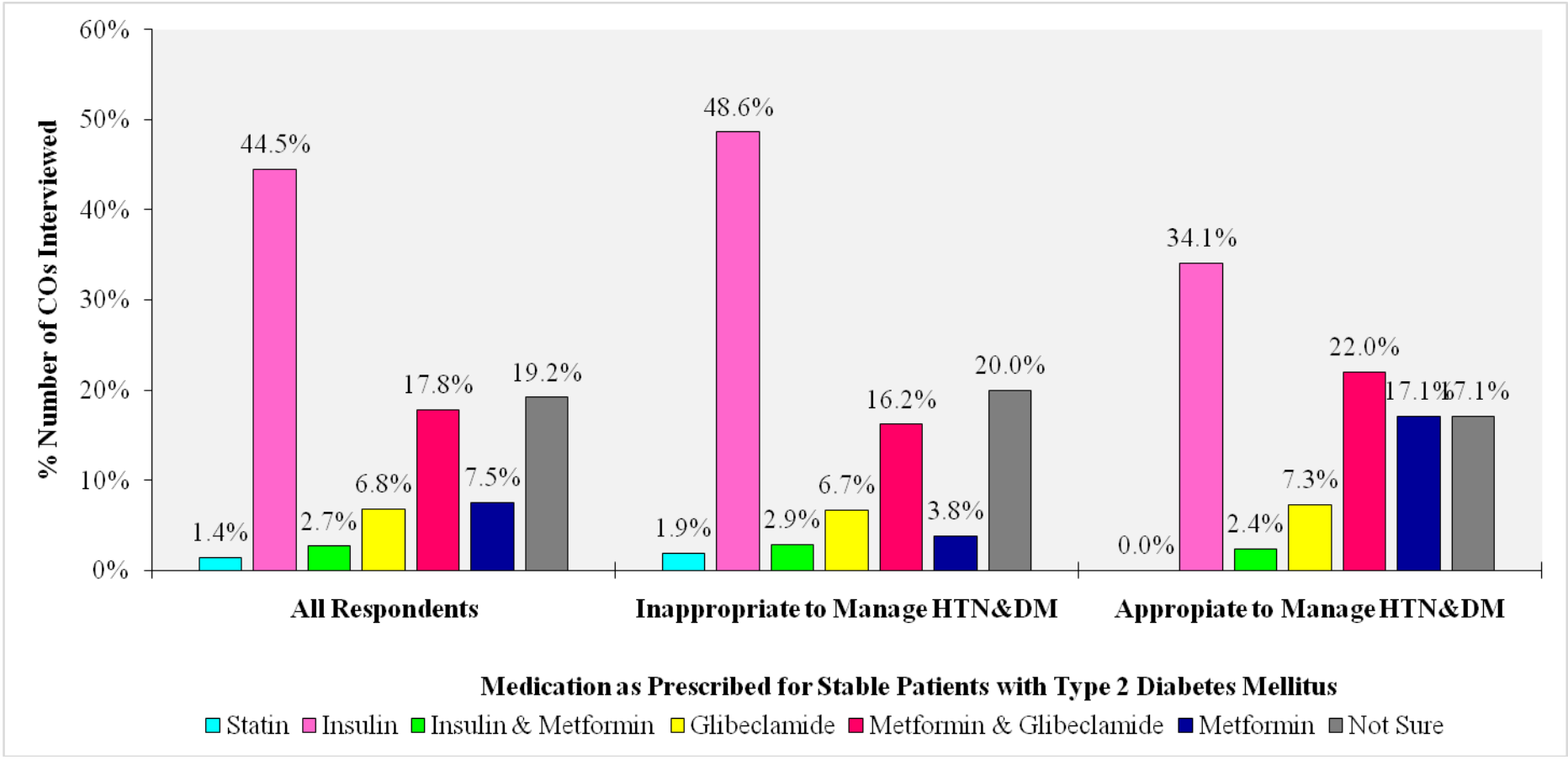

Figure 4: Medication as Prescribed by Clinical Officers for Patients with Hypertension in Diabetes Mellitus

Data presented are frequency distribution (%) of responses, stratified into those who can or cannot appropriately manage HTN&T2DM. Abbreviations: CCB, Calcium Channel Blockers; ARB, Angiotensin Receptor Blocker; ACEI, Angiotensin-converting Enzyme Inhibitor

4.4.2 Prescriptions of First-line Medicines Recommended by Clinical Officers for Patients with Type 2 Diabetes Mellitus

Analyses were conducted to determine medication COs prescribed for the management of patients with type 2 diabetes mellitus (Figure 5). Results showed that 44.5% (n=65) of all participants prescribed insulin, 17.8% (n=26) metformin and glibenclamide combination and 19.2% (n=28) were not sure. Only 7.5% (n=11) of all respondents reported the correct first line medication for type 2 diabetes mellitus, metformin (Figure 5).

Further, 48.6% (n=51) of participants who indicated insulin were in the category of COs unable to appropriately manage patients presenting with HTN&T2DM, 16.2% (n=17) mentioned metformin and glibenclamide combination while 20.0% (n=21) reported not knowing. Only 3.8% (n=4) of participants mentioned the right first-line medicine for patients with stable type 2 diabetes mellitus. Besides, 34.1% (n=14) of COs in the group able to manage patients with HTN&T2DM prescribed insulin, 22.0% (n=9) mentioned metformin and glibenclamide combination and 17.1% (n=7) were not sure. Interestingly, 17.1% (n=7) indicated metformin, the correct first-line drug for the management of patients with stable type 2 diabetes mellitus (Figure 5).

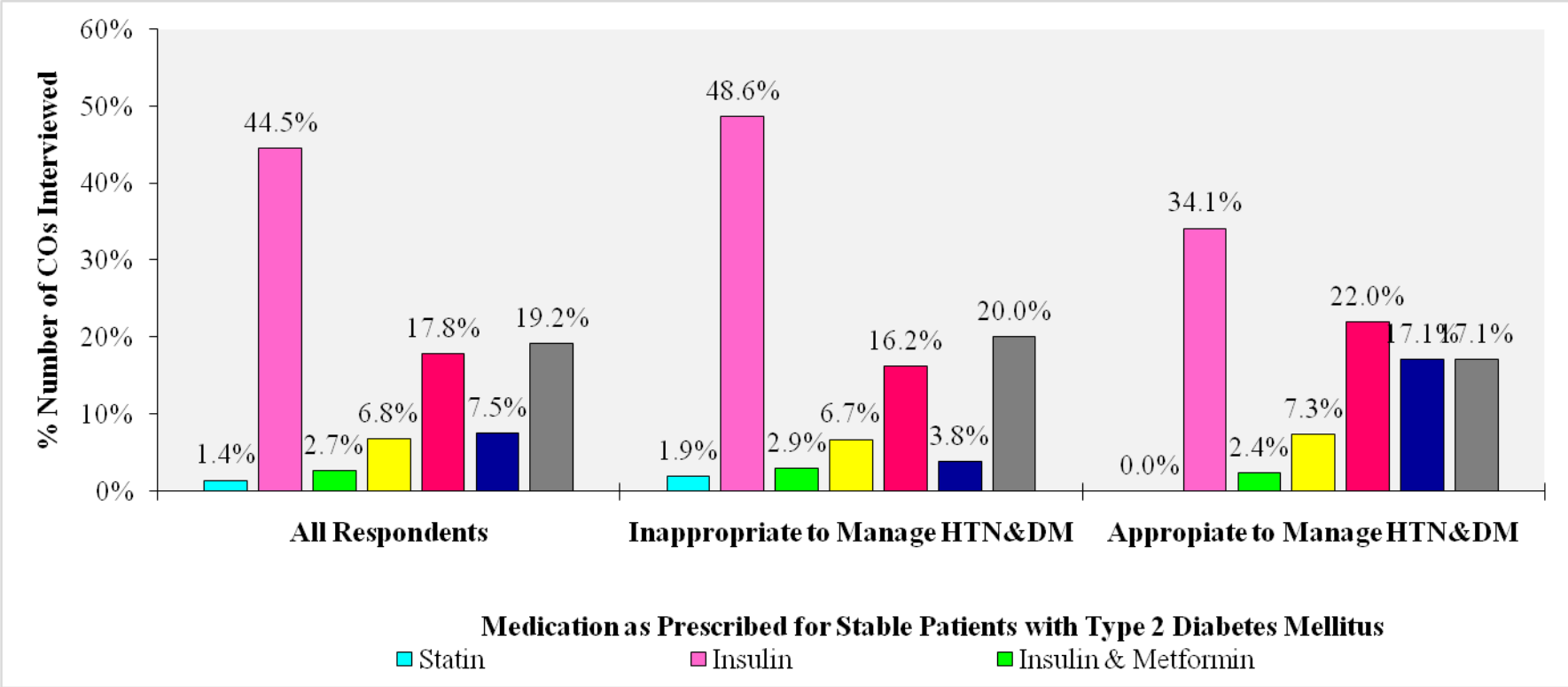

Figure 5: Medication as Prescribed by Clinical Officers to Patients Presenting with Stable Type 2 Diabetes Mellitus
Frequencies distribution proportions of medicines prescribed to patients by Clinical Officers' as first-line treatment of Type 2 diabetes mellitus. Data presented are frequency distribution (%) of responses, stratified into those who can or cannot manage HTN&T2DM appriopriately.

4.4.3 Correct First-line Medication for Management of Patients Presenting with Hypertension or Type 2 Diabetes Mellitus

The assessment was conducted to determine the proportion of clinical officers who prescribed the correct first-line medication for patients presenting with a condition associated with HTN&T2DM (Figure 6). For patients presenting with hypertension in diabetes mellitus, 27.4% (n=40) of all respondents prescribed ACEI, the correct first-line drug. While 22.9% (n=24) of participants not able to manage patients indicated ACEI as a drug of choice for patients with hypertension, 39.0% (n=16) of those able to treat HTN&T2DM were able to prescribe the right medication (Figure 6).

Management of patients presenting with stable type 2 diabetes mellitus requires the use of metformin as a first-line drug, as was prescribed by 7.5% (n=11) of all study participants. While only 3.8% (n=4) of COs not able to manage HTN&T2DM indicated metformin as a first line drug, 17.1% (n=7) of respondents able to manage HTN&T2DM stated the correct medication for stable type 2 diabetes mellitus (Figure 6).

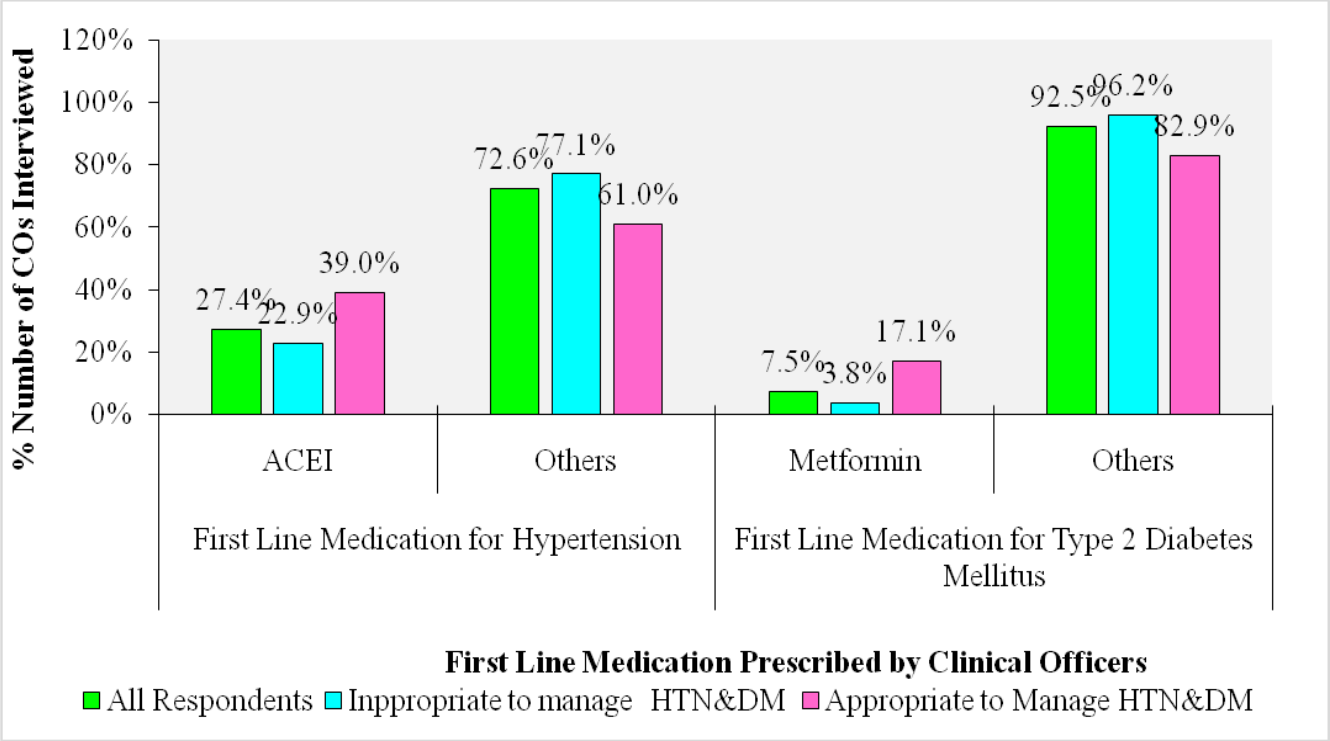

Figure 6 : First Line Medication as Prescribed by Clinical Officers to Patients Presenting with Hypertension and type 2 diabetes mellitus

Frequencies distribution proportions of medicines prescribed to patients by Clinical Officers' as first-line treatment of Type 2 diabetes mellitus. Data presented are frequency distribution (%) of responses, stratified into those who can or cannot manage HTN&T2DM.

4.4.4 Association between Prescription of Correct First-line Medication and Care of Hypertension and Type 2 Diabetes Mellitus

Regression analysis on assessing the association between prescription of first-line medication and the appropriate management of patients with hypertension in diabetes mellitus revealed that COs who prescribed ACEI showed higher odds of appropriate management of patients presenting to them (OR=2.116, 95% CI; 1.168-4.628, *P*=0.040), relative to respondents who prescribed different drugs. Additional analyses of the association between first-line medications for management of patients with stable type 2 diabetes mellitus and control of HTN&T2DM revealed that COs who prescribed metformin as firstline medicine had increased odds of appropriate management of patients (OR=5.250, 95% CI; 1.376-20.036, *P*=0.015), relative to participants who prescribed different drugs for managing patients with stable type 2 diabetes mellitus (Table 14).

Table 14: Association between Prescription of Correct First-line Medication and Management of Hypertension and Type 2 Diabetes Mellitus Patients

	1st Line Medication	Odds Ratio	95% CI	*P*-value
Hypertension	Other medicines	Ref.	-	-
	ACEI	2.116	1.168-4.628	**0.040**
Type 2 Diabetes Mellitus	Other medicines	Ref.	-	-
	Metformin	5.250	1.376-20.036	**0.015**

Binary logistic regression analysis was performed to assess the association between medication prescribed by Clinical Officers as first-line treatment for hypertension and diabetic patient and inappropriate care for patients. The regression model controlled for the confounding effect of age between groups. Data are presented as odds ratio (OR) and 95% confidence interval (CI). Abbreviations: BP, Blood Pressure; Ref., Reference variable.

4.4.5 Clinical Offices' Knowledge on Management of Pre-hypertensive Patients

Clinical officers were asked to indicate how they managed patients with pre-hypertension. The results showed that 87.7% (n=128) of the COs advised patients to modify their lifestyles, while 6.8% (n=10) prescribed anti-hypertensive medications in addition to advice on lifestyle modification and 5.5% (n=8) administered anti-hypertensive therapies (Table15).

Further classification of COs into those who appropriately or inappropriately managed HTN&T2DM revealed that 75.6% (n=31) of participants who advised patients on lifestyle modifications were able to manage patients who presented with HTN&T2DM. In addition, proportion distribution of management of pre-hypertension varied significantly (*P*=0.001) between COs with ability to appropriately or not appropriately treat patients with HTN&T2DM (Table 15).

Table 15: Knowledge of Clinical officers on the management of pre-hypertensive patients

Category	Total n=146	Inappropriate management n=105	Appropriate management n=41	*P*-value
	n (%)	n (%)	n (%)	
Antihypertensive	8 (5.5)	6 (5.7)	2 (4.9)	**0.001**
Antihypertensive and lifestyle modification	10 (6.8)	2 (1.9)	8 (19.5)	
Lifestyle modification	128 (87.7)	97 (92.4)	31 (75.6)	

Frequency distribution of clinical officers' knowledge on the management of patients with pre-hypertension. Data are presented as absolute number (n) and percentages (%). Statistical significance computed using the chi-square test.

4.4.6 Association between Clinical Officers' Knowledge on Treatment of Patients with Pre-hypertension and Management of Hypertension and Type 2 Diabetes Mellitus Patients

Binary logistic analysis results showed that COs who advised pre-hypertensive patients on lifestyle medication and respondents who simultaneously prescribed anti-hypertension medication and advised on lifestyle modifications demonstrated increased odds of appropriate management of patients with HTN&T2DM which was statistically significant (OR=10.305, 95% CI; 1.059-100.290, *P*=0.004) (Table 16).

Table 16: Association between clinical officers' knowledge of pre-Hypertension in Type 2 Diabetes Mellitus patient and Management of HTN&T2DM

Category	Odds Ratio	95% CI	*P*-value
Antihypertensive medication	Ref.	-	-
Anti-hypertensive medication and Lifestyle Modification	10.305	1.059-100.290	**0.044**
Lifestyle Modification	1.816	0.145-4.597	0.082

Binary logistic regression analysis was performed to assess the association between clinical officers' knowledge of management of pre-hypertensive patients and inappropriate to manage hypertension and type 2 diabetes mellitus. The regression model controlled for the confounding effect of age between groups. Data are presented as odds ratio (OR) and 95% confidence interval (CI). Abbreviation: Ref., Reference variable.

4.4.7 Clinical Officers Knowledge on Lifestyle Modification for Patients with Hypertension

All (n=146) COs' indicated they would recommend low salt diets for pre-hypertensive patients (Figure 7). A further 67.8% (n=99) participants indicated low fat intake, of whom 57.1% (n=59) were unable to manage patients with HTN&T2DM and 95.1% (n=39) could manage patients presented to them. Only 7.5% (n=11) recognized regular exercise as an

important life modification option for hypertensive patients, 9.8% (n=4) of whom were able to manage patients with HTN&T2DM. In addition, 29.0% (n=42) of participants identified reduced alcohol intake, with 34.9% (n=14) being able to manage HTN&T2DM patients. Cessation of smoking was mentioned by 27.4% (n=40) of all study participants, of whom 19.5% (n=8) were in the category that could manage patients with HTN&T2DM. Weight reduction was identified as a life-modification strategy for hypertensive patients by only 9.6% (n=14) of participating COs, with 9.8% (n=4) being able to manage HTN&T2DM (Figure 7).

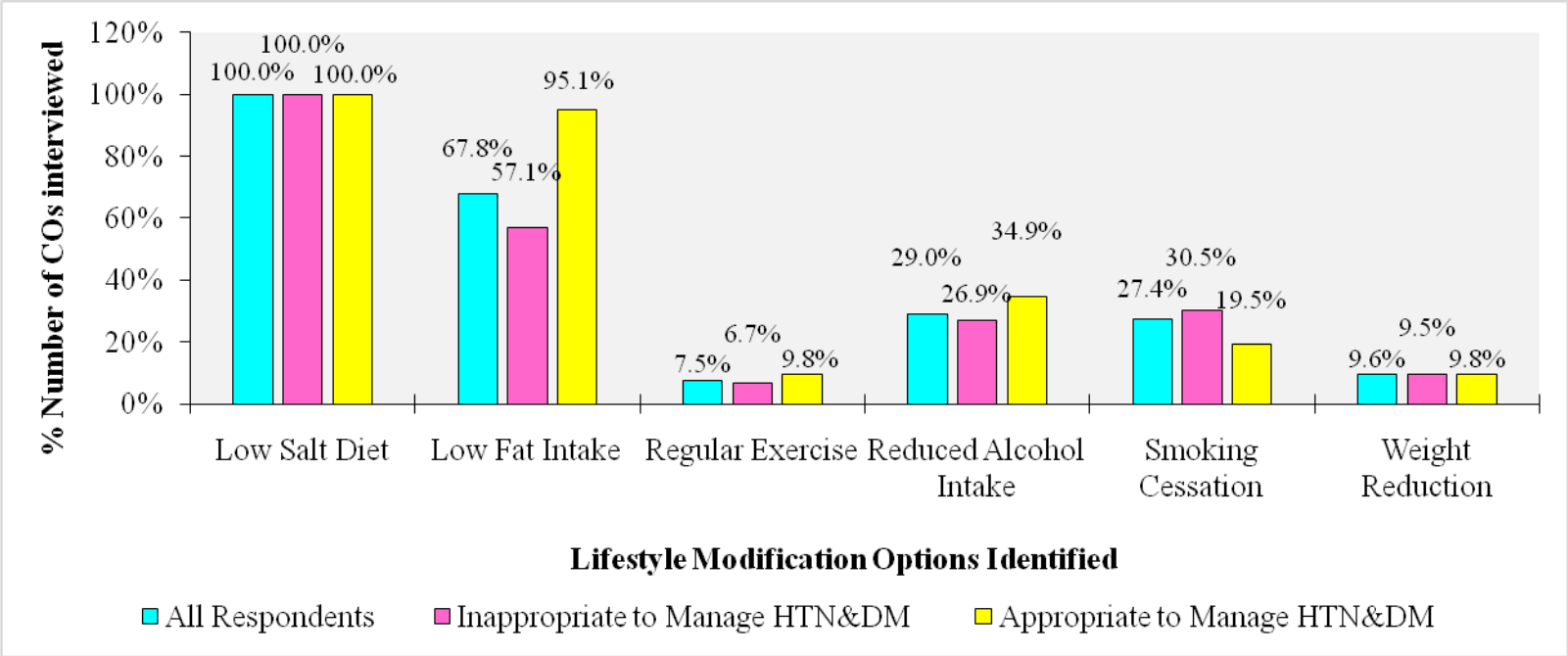

Figure 7: Life modification options for hypertension patients

Clinical officers (n=146) were asked to indicate the life modification option they would recommend to patients presenting with hypertension. Data presented are frequency distribution (%) of responses, stratified into those who can or cannot manage HTN&T2DM.

4.4.8 Clinical Officers Follow-up Strategies for Patients with Diabetes Mellitus and Hypertension

Clinical officers were asked to indicate whether they followed up a patient with HTN&T2DM at their health centers (Figure 8). Results showed that 68.5% (n=100) stated that patients with HTN&T2DM were followed up and 31.5% (n=46) indicated they did not follow patients. Of these, 68.3% (n=28) were in the category of COs were able to manage patients with HTN&T2DM. Additional analyses revealed that 49.0% (n=49) said they scheduled return visit days for their patients, with 60.7% (n=17) of them able to manage patients with HTN&T2DM. Further, only 30.0% (n=30) of respondents indicated having specific staff assigned to manage patients with HTN&T2DM at their health facilities, while 70% (n=70) said no staff were assigned. Of COs with assigned staff, 39.3% (n=11) were able to manage patients with HTN&T2DM. In addition, 29.0% (n=29) of participants indicated their health facilities had designed rooms dedicated to management of HTN&T2DM patients, while 71.0% (n=71) had no specific room for management. Of those with special rooms, 32.1% (n=9) were able to manage patients with HTN&T2DM (Figure 8).

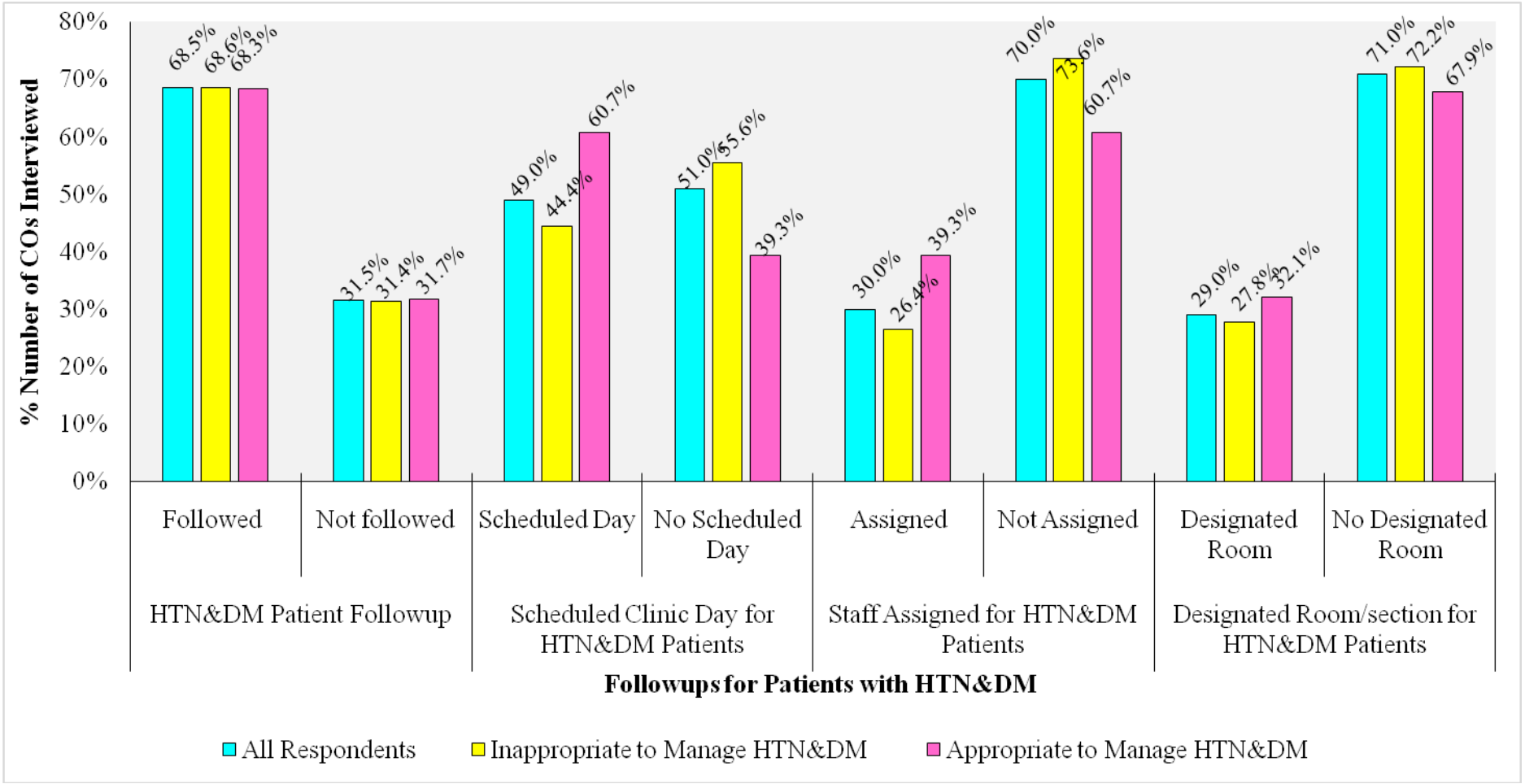

Figure 8: Follow-up Strategies Utilized by Clinical officers for patients with Hypertension and type 2 diabetes mellitus
Clinical officers (n=146) responded to follow-up schedules they utilize for patients presenting with HTN&T2DM. Data presented are frequency distribution (%) of responses, stratified into those who can or cannot manage HTN&T2DM.

4.4.9 Association between Patients Follows-up and Management of Patients with Hypertension and Type 2 Diabetes Mellitus

Regression analysis of association revealed not statistically significant for ability to follow-up (OR, 0.897; 95% CI, 0.393-2.048; *P*=0.796), availability of a dedicated clinical day for HTN&T2DM (OR, 2.065; 95% CI, 0.809-5.267; *P*=0.129), availability of staff assigned and designated room or section for management of patients with HTN&T2DM (OR, 1.818; 95% CI, 0.718-4.600; *P*=0.207) and (OR, 1.245; 95% CI, 0.473-3.277; *P*=0.657), respectively. However, health facilities with follow-up structures, namely; ability to follow-up, specific day for HTN&T2DM patients, staff assigned to manage HTN&T2DM and assigned rooms during follow-up session had statistically significant high odds of appropriate management of patients with HTN&T2DM (OR, 18.627; 95% CI, 3.902-88.912; *P*<0.001), relative to health facilities where no follow-up structures were present (Table 17), suggesting that availability of a patient follow-up structure in a health facility is important for appropriate management for patients with HTN&T2DM.

Table 17: Association between Patient Follow-up and Clinical Officers Management of Patients with Hypertension and Type 2 Diabetes Mellitus

Category	Characteristics	Odds Ratio	95% CI	*P*-value
Ability to follow up	Able to follow	Ref.	-	-
	Unable to follow	0.897	0.393-2.048	0.796
Assigned clinic day	No Assigned day	Ref.	-	-
	Assigned day for followup	2.065	0.809-5.267	0.129
Assigned staff in NCD clinic	No ssigned staff	Ref.	-	-
	Assigned assigned	1.818	0.718-4.600	0.207
Assigned Room for follow up	No room available	Ref.	-	-
	Room dedicated	1.245	0.473-3.277	0.657
Assigned day, staff and room combined	Not available	Ref.	-	-
	All available	18.627	3.902-88.912	**<0.001**

Binary logistic regression analysis was performed to assess the association between clinical officers' ability to follow-up patients and inappropriate management hypertension and type 2 diabetes mellitus. The regression model controlled for the confounding effect of age between

groups. Data are presented as odds ratio (OR) and 95% confidence interval (CI). Abbreviation: Ref., Reference variable.

4.5 Availability and Utilization of Equipment and Guidelines for Management of Patients with Hypertension and Type 2 Diabetes Mellitus

Management of patients with HTN&T2DM requires knowledge of the equipment necessary, the ability to use this equipment and their availability. As such, clinical officers were asked to identify essential equipment presented to them that would often be required to manage patients presenting with HTN&T2DM, demonstrate their use and indicate accessibility or ownership.

4.5.1 Identification, Ability to Use and Ownership of Equipment Utilized for Management of Hypertension and Type 2 Diabetes Mellitus

Assessment of ability to identify, use and access to equipment showed that all COs interviewed were able to identify and use a stethoscope, but only 79.5% (n=116) had access or owned one, and proportions were comparable between COs able versus those not able to manage patients with HTN&T2DM (Table 18).

Further, 93.2% (n=136) of interviewed respondents were able to identify a patella hammer, 74.0% (n=108) demonstrated its usage but only 26.0% (n=38) had access or owned one. Interestingly, 82.9% (n=34) of COs who could identify the patella hammer was in the category of those able to offer appropriate management to patients with HTN&T2DM, a variation that was statistically different from participants unable to appropriately manage patients presenting to them (P=0.002). Similarly, there as a variation in access/ownership of the patella hammer between COs able to manage HTN&T2DM relative to those unable (P=0.017), but no variation in proportion distribution for its usage (P=0.890) (Table 18).

All respondents interviewed positively identified a weighing scale, 96.6% (n=146) were able to use it, but only 45.2% (n=66) reported access or ownership of one. There was a variation in the distribution of availability of weighing scales between COs able to provide

approapriate management to patients with HTN&T2DM, relative to those who were not able (*P*=0.041), but the usage of the weighing scale was comparable between the groups (*P*=0.682) (Table 18).

Similarly, 97.3% (n=0.142) of interviewed COs were able to identify a pen torch, 80.1% demonstrated its use and only 41.1% (n=60) had access to one. However, the proportions of knowledge (*P*=0.889), usage (*P*=0.392) and ownership (*P*=0.286) were comparable between participants able to appropriately versus those not able to manage patients with HTN&T2DM (Table 18).

The Ophthalmoscope was positively identified by 42.5% (n=62), while its usage was demonstrated by 24.7% (n=36), but none of the COs interviewed had access to or owned one. Although there was no variation in the knowledge proportions of the ophthalmoscope between participants able to approapriately or not able to manage HTN&T2DM (*P*=0.100), there as a significant variation in its usage (*P*=0.009) (Table 18).

The tape measure was identified by all COs interviewed, 63.4% (n=92) demonstrated its usage and 45.9% (n=67) indicated ownership or availability or access to one. As such, the distribution proportions between COs able to manage appropriately or not able to manage were comparable for those able to use the tape measure (*P*=0.706) or had access to one (*P*=0.298) (Table 18).

Although only 49.3% (n=72) were able to identify a tuning fork, all interviewed COs demonstrated its use, but only 9.6% (n=14) had access to a tuning fork. The proportion distribution was comparable between COs able versus those unable to manage HTN&T2DM for knowledge (*P*=0.120) or those with or without access (*P*=0.227) (Table 18).

The Sphygmomanometer was correctly identified by 91.1% (n=133), with 97.9% (n=143) demonstrating its usage, but only 54.8% (n=80) confirmed being able to access one. However, the distribution of proportions between COs able versus unable to manage to

manage HTN&T2DM was comparable for those able to identify the Sphygmomanometer (*P*=0.383), demonstrate its use (*P*=0.838) or ownership of one (*P*=0.843) (Table 18).

The glucometer was correctly identified by 89.7% (n=131) of all interviewed participants, with 79.5% (n=116) demonstrated its correct usage, with only 31.5% (n=46) had access to one for management of patients presenting with HTN&T2DM. There were no variations in proportion distribution between COs able to appropriately or not able to manage patients and ability to identify a glucometer (*P*=0.898), demonstrate its usage (*P*=0.473), but varied for accessibility to a glucometer (*P*=0.051) (Table 18).

Table 18: Identification, ability to Use and Availability of Equipment Utilized for Management of Hypertension and Type 2 Diabetes Mellitus

Equipment	**Knowledge, Usage and Availability of Equipment**		**Total n=146**	**Inappropriate management n=105**	**Appropriate management n=41**	***P*-value**
			n (%)	**n (%)**	**n (%)**	
Stethoscope	Knowledge	Yes	146 (100.0)	105 (100.0)	41 (100.0)	-
		No	0 (0.0)	0 (0.0)	0 (0.0)	
	Usage	Yes	146 (100.0)	105 (100.0)	41 (100.0)	-
		No	0 (0.0)	0 (0.0)	0 (0.0)	
	Available	Yes	116 (79.5)	87 (82.9)	29 (7007)	0.103
		No	30 (20.5)	18 (17.1)	12 (29.3)	
Patella Hammer	Knowledge	Yes	136 (93.2)	102 (97.1)	34 (82.9)	**0.002**
		No	10 (6.8)	3 (2.9)	7 (17.1)	
	Usage	Yes	108 (74.0)	78 (74.3)	30 (73.2)	0.890
		No	38 (26.0)	27 (25.7)	11 (26.8)	
	Available	Yes	38 (26.0)	33 (31.4)	5 (12.2)	**0.017**
		No	108 (74.0)	74 (68.6)	36 (87.8)	
Weighing scale	Knowledge	Yes	146 (100.0)	105 (100.0)	41 (100.0)	-
		No	0 (0.0)	0 (0.0)	0 (0.0)	
	Usage	Yes	141 (96.6)	101 (96.2)	40 (97.6)	0.682
		No	5 (3.4)	4 (3.8)	1 (2.4)	
	Available	Yes	66 (45.2)	53 (50.5)	13 (31.7)	**0.041**
		No	80 (54.8)	52 (49.5)	28 (68.3)	
Pen Torch	Knowledge	Yes	142 (97.3)	102 (97.1)	40 (97.6)	0.889
		No	4 (2.7)	3 (2.9)	1 (2.4)	
	Usage	Yes	117 (80.1)	86 (81.9)	31 (75.6)	0.392
		No	29 (19.9)	19 (18.1)	10 (24.4)	
	Available	Yes	60 (41.1)	46 (43.8)	14 (34.1)	0.286
		No	86 (58.9)	59 (56.2)	27 (65.9)	
Ophthalmoscope	Knowledge	Yes	62 (42.5)	49 (46.7)	13 (31.7)	0.100
		No	84 (57.5)	56 (53.3)	28 (68.3)	

Equipment	Knowledge, Usage and Availability of Equipment		Total n=146	Inappropriate management n=105	Appropriate management n=41	*P*-value
			n (%)	n (%)	n (%)	
	Usage	Yes	36 (24.7)	32 (30.5)	4 (9.8)	**0.009**
		No	110 (75.3)	73 (69.5)	37 (90.2)	
	Available	Yes	0 (0.0)	0 (0.0)	0 (0.0)	-
		No	146 (100.0)	105 (100.0)	41 (100.0)	
Tape Measure	Knowledge	Yes	146 (100.0)	105 (100.0)	41 (100.0)	-
		No	0 (0.0)	0 (0.0)	0 (0.0)	
	Usage	Yes	92 (63.4)	65 (62.5)	27 (65.9)	0.706
		No	53 (36.6)	39 (37.5)	14 (34.1)	
	Available	Yes	67 (45.9)	51 (48.6)	16 (39.0)	0.298
		No	79 (54.1)	54 (51.4)	25 (61.0)	
Tuning Fork	Knowledge	Yes	72 (49.3)	56 (53.3)	16 (39.0)	0.120
		No	74 (50.7)	49 (46.7)	25 (61.0)	
	Usage	Yes	146 (100.0)	105 (100.0)	41 (100.0)	-
		No	0 (0.0)	0 (0.0)	0 (0.0)	
	Available	Yes	14 (9.6)	12 (11.4)	2 (4.9)	0.227
		No	132 (90.4)	93 (88.6)	39 (95.1)	
Sphygmomanometer	Knowledge	Yes	133 (91.1)	97 (92.4)	36 (87.8)	0.383
		No	13 (8.9)	8 (7.6)	5 (12.2)	
	Usage	Yes	143 (97.9)	103 (98.1)	40 (97.6)	0.838
		No	3 (2.1)	2 (1.9)	1 (2.4)	
	Available	Yes	80 (54.8)	57 (54.3)	23 (56.1)	0.843
		No	66 (45.2)	48 (45.7)	18 (43.9)	
Glucometer	Knowledge	Yes	131 (89.7)	94 (89.5)	37 (90.2)	0.898
		No	15 (10.3)	11 (10.5)	4 (9.8)	
	Usage	Yes	116 (79.5)	85 (81.0)	31 (75.6)	0.473
		No	30 (20.5)	20 (19.0)	10 (24.4)	
	Available	Yes	46 (31.5)	38 (36.2)	8 (19.5)	**0.051**
		No	100 (68.5)	67 (63.8)	33 (80.5)	

Frequency distribution of clinical officers' ability to Identify, use or own equipment commonly utilized in the management of patients with pre-hypertension. Data are presented as absolute number (n) and percentages (%). Statistical significance computed using the chi-square test.

Further classification of equipment based on the total number identified, used or owned by COs showed that all respondents were able to identify more than 5 equipment presented to them. On the number of COs with knowledge and ability to use the equipment shown to them, 91.1% (n=155) of the participants were able to use five of more equipment, with 92.4 (n=97) in the category of COs unable to manage patients with HTN&T2DM, while 87.8 (n=36) able to manage the patients. In addition, 47.3% (n=69) of interviewed COs indicated

that they owned or had access to four or more equipment necessary to be able to manage patients with HTN&T2DM, with 51.4% (n=54) in the category unable to manage HTN&T2DM and 36.6% (n=15) able to manage patients presenting with HTN&T2DM (Table 19).

Table 19: Number of Equipment Identified, Used or Owned by COs and Management of Hypertension and Type 2 Diabetes Mellitus

Equipment	Number of Equipment	Total n=146	Inappropriate Management n=105	Appropriate Management n=41	*P*-value
		n (%)	n (%)	n (%)	
Identification of the equipment presented	≤ 4	0 (0.0)	0 (0.0)	0 (0.0)	-
	≥ 5	146 (100.0)	105 (100.0)	41 (100.0)	
Knowledge of use of equipment presented	≤ 4	13 (8.9)	8 (7.6)	5 (12.2)	0.383
	≥ 5	155 (91.1)	97 (92.4)	36 (87.8)	
Availability of equipment presented	≤ 4	77 (52.7)	51 (48.6)	26 (63.4)	0.106
	≥ 5	69 (47.3)	54 (51.4)	15 (36.6)	

Frequency distribution of the number of equipment correctly identified by clinical officers, their ability to use our equipment for the management of patients with pre-hypertension, Data are presented as absolute number (n) and percentages (%). Statistical significance computed using the chi-square test

4.5.2 Association between Number of Equipment Identified, Used or Owned by COs and Management of HTN&T2DM Patients

The results revealed no diference between apriopriate management of HTN&T2DM and use four or more equipment (OR, 1.667; 95% CI, 0.511-5.441; *P*=0.397), relative to COs able to use five or more equipment (Table 20).

Table 20: Association between Number of Equipment Identified, Used or Owned by COs and COs inappropriate management of HTN&T2DM Patients

Equipment	Number of Equipment	Odds Ratio	95% CI	*P*-value
Knowledge of the equipment presented	≤ 4	Ref.	-	-
	≥ 5	-	-	-
Ability to use equipment presented	≤ 4	Ref.		-
	≥ 5	1.667	0.511-5.441	0.397
Availability of equipment presented	≤ 4	Ref.	-	-
	≥ 5	0.528	0.245-1.104	0.089

Binary logistic regression analysis was performed to assess the association between clinical officers' ability to identify, use or own key equipment utilized in the management of hypertension and type 2 diabetes mellitus. The regression model controlled for the confounding effect of age between groups. Data are presented as odds ratio (OR) and 95% confidence interval (CI). Abbreviation: Ref., Reference variable.

4.5.3 Availability of Treatment Protocols and/or Guidelines

In this study, clinical officers interviewed were asked to respond to the availability of HTN&T2DM management protocols or guidelines at their respective health facilities. Results revealed that only 37.0% (n=54) of all participants reported having guidelines for the management of hypertension, and 19.9% (n=29) reported being in possession of guidelines for the management of diabetes. Further analyses showed that only 2.7% (n=4) each of respondents had guidelines for management of stroke, heart failure and renal diseases, respectively (Table 21).

Table 21: Availability of Treatment Protocols and Guidelines

Category	Availability	Total n=146	Inadequate n=105	Adequate n=41
		n (%)	n (%)	n (%)
Hypertension Guidelines	Yes	54 (37.0)	20 (19.0)	34 (82.9)
	No	92 (63.0)	85 (81.0)	7 (17.1)
Diabetes Guidelines	Yes	29 (19.9)	12 (11.4)	17 (41.5)
	No	117 (80.1)	93 (88.6)	24 (58.5)
Stroke Guidelines	Yes	4 (2.7)	4 (3.8)	0 (0.0)
	No	142 (97.3)	101 (96.2)	41 (100.0)
Heart Failure Guidelines	Yes	4 (2.7)	1 (1.0)	3 (7.3)
	No	142 (97.3)	104 (99.0)	38 (92.7)
Renal Disease Guidelines	Yes	4 (2.7)	3 (2.9)	1 (2.4)
	No	142 (97.3)	102 (97.1)	40 (97.6)

Frequency distribution availability of guidelines for Hypertension and type 2 diabetes mellitus Data are presented as absolute number (n) and percentages (%).

4.5.4 Association between Availability of Treatment Guidelines and Appriopriate management of Hypertension and Type 2 Diabetes Mellitus

Binary logistic regression analysis revealed that availability of guidelines for management of hypertension had significant association and had more odds of appropriate management of patients with HTN&T2DM relative to those who reported the unavailability of guidelines.

(OR,21.339; 95% CI, 8.197-55.863; *P*<0.001). Similarly, COs with protocols for management of diabetes had more odds of adequate care of HTN&T2DM compared to those with no guidelines (OR, 5.443; 95% CI, 2.290-12.934; *P*<0.001). There was a marginal association between availability of guidelines for management of heart failure and the ability of COs to manage patients with HTN&T2DM, although this association was not statistically significant (OR, 7.773; 95% CI, 0.767-78.779; *P*=0.083). No significant relationship was observed between availability of guidelines renal diseases and the respondents management of HTN&T2DM (OR, 1.309; 95% CI, 0.103-13.233; *P*=0.820) (Table 22). Analysis revealed that availability of guidelines for management of hypertension had significant more odds of ability to diagnose HTN&T2DM relative to those who reported the unavailability of guidelines (OR, 18.556; 95% CI 7.221-47.684; *P*<0.001) (Table 22).

Table 22 : Association between Availability of Treatment Protocols and/or Guidelines and Management of patients with HTN&T2DM

Category	Availability	Odds Ratio	95% CI	*P*-value
Hypertension Guidelines	No	Ref.	-	
	Yes	21.399	8.197-55.863	**<0.001**
Diabetes Guidelines	No	Ref.	-	-
	Yes	5.443	2.290-12.934	**<0.001**
Heart Failure Guidelines	No	Ref.	-	-
	Yes	7.773	0.767-78.779	0.083
Renal Disease Guidelines	No	Ref.	-	-
	Yes	1.309	0.103-13.233	0.820
All guidelines available	No	Ref.	-	-
	Yes	18.556	7.221-47.684	**<0.001**

Binary logistic regression analysis was performed to assess the association between the availability of guidelines for the treatment of patients with hypertension and type 2 diabetes mellitus and the ability of COs to care them. The regression model controlled for the confounding effect of age between groups. Data are presented as odds ratio (OR) and 95% confidence interval (CI). Abbreviation: Ref., Reference variable.

4.5.5 Association between Availability of Treatment Guidelines and Treatment of Hypertension and Type 2 Diabetes Mellitus

Binary logistic regression analysis revealed that availability of guidelines for management of hypertension had significant association and had more odds of ability to treat HTN&T2DM relative to those who reported the unavailability of guidelines (OR, 4.247; 95% CI 2.049-8.673; *P*<0.001) (Table 23).

Table 23: Association between Availability of Treatment Guidelines and Treatment of Hypertension and Type 2 Diabetes Mellitus

Category	Availability	Odds Ratio	95% CI	*P*-value
Guidelines	No	Ref.	-	
	Yes	4.247	2.049-8.673	**<0.001**

Binary logistic regression analysis was performed to assess the association between the availability of guidelines for the treatment of patients with hypertension and type 2 diabetes mellitus and diagnosis. The regression model controlled for the confounding effect of age between groups. Data are presented as odds ratio (OR) and 95% confidence interval (CI). Abbreviation: Ref., Reference variable.

CHAPTER FIVE
DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

This study aimed at determining the knowledge and skills and the environment in which clinical officers work for appropriate care of a patients presenting with hypertension and type 2 diabetes mellitus at rural healthcare facilities in Kisumu County, Kenya. The study, investigated the clinical officers ability to diagnose, treat and follow-up of patients presenting with HTN&T2DM. It also investigated the availability of medical equipment and treatment guidelines in rural health facilities. A total number of 146 [63 female (43.2%) and 83 males (56.8%)] Clinical Officers spread out in 56 public health facilities we recruited into the study. Overall, the results presented showed that knowledge of predisposing risk factors to HTN&T2DM (OR=9.256; 95% CI: 3.936-21.768; *P*<0.001), capacity to perform a complete physical examination on HTN&T2DM patients (OR=18.111, 95 CI; 1.433-228.884, *P*=0.025), ability to identify first-line medication for treatment of type 2 diabetes mellitus (OR=5.250, 95% CI; 1.376-20.036, *P*=0.015), availability of assigned patient follow-up clinic day, staff and dedicated room/section (OR, 18.627; 95% CI, 3.902-88.912; *P*<0.001) and availability of treatment guidelines for the management of hypertension (OR, 21.339; 95% CI, 8.197-55.863; *P*<0.001) and diabetes mellitus (OR, 5.443; 95% CI, 2.290-12.934; *P*<0.001), simultaneous prescription anti-hypertension medication and advice on lifestyle modification strategies (OR, 10.305; 95% CI, 1.059-100.290; *P*=0.044) were all associated with the appriopriate management of patients presenting with HTN&T2DM by clinical officers.

5.1.1 Demographic Characteristics of Study Participants

The study showed no variability in gender distribution, duration of service, the level of healthcare facility, department within the healthcare facility, and employer. We analyzed the Clinical officers' capability to appropriately manage patients with HTN&T2DM. Although a

previous study reported a reduction in doctor's knowledge after 10 years of experience (Van Leeuwen et al. 1995), the results presented here compare with those of a study in Egypt that saw no significant association between the doctor's years of experience and percentage mean knowledge score (Abolfotouh et al. 2011). There was association between the duration of service a CO had served post internship or the level of health facility the participant worked in or their employer and care for patients with HTN&T2DM.

Quality training that is relevant to the management of patients with HTN&T2DM is mandatory for effective intervention. The level of training and the relevance of training taken up by COs post-diploma were assessed. We noted that despite 46.2% of all respondents having completed some form of training at a post-diploma level, with a higher proportion (65.1%) completing degree courses, there was no evidence that the additional training translated to appropriate management of HTN&T2DM.

A previous study on the knowledge of HTN&T2DM among healthcare workers showed that the significant challenge in Sub-Sahara Africa (Alebiosu 2009) was inadequate post-basic training opportunities for management of NCDs (Alebiosu 2009). Studies in south-west Nigeria (Alebiosu 2009) and Egypt (Abolfotouh et al. 2011) indicate the importance of adequate training of primary care physicians on the management of hypertension. In this study, there was appropriate management of HTN&T2DM by clinical officers who had training specific for HTN and/or DM, but better in those who had training in both HTN&T2DM.

5.1.2 Diagnosis Procedures for Patients Presenting with HTN&T2DM

Critical to the management of HTN&T2DM is knowledge of the predisposing risk factors. The Kenya national guidelines identify ten risk factors for the development of HTN&T2DM care. The risk factors include; age, alcohol abuse, ethnicity, dyslipidemia, first degree relative with the condition, impaired glucose tolerance, obesity, physical inactivity, tobacco use and

unhealthy diets (MOH 2018). While assessing Clinical officers' response to knowledge of HTN&T2DM risk factors, 28.8% identified only two risk factors, 26.7% identified three risk factors, 13.7% four risk factors and 1.4% five risk factors. It transpired that 78.0% of COs who knew three or more risk factors demonstrated appropriate management of HTN&T2 DM and 36.2% of COs who inappropriately managed HTN&T2DM only knew two risk factors; presenting a significant variation in the proportion distribution (P<0.001). These results correlate well to those of a regression modelling on the association between the number of risk factors identified and the ability to manage HTN&T2DM. Participants who identified less than three predisposing risk factors were unable to adequately manage patients with HTN&T2DM (P<0.001). These results compare with a study in Egypt which eluded to the fact that the availability of clinical history recording system was associated with physicians level of knowledge to manage hypertension (Abolfotouh et al. 2011).

In addition to knowledge on predisposing risk factors to the development of HTN&T2DM, the ability of a healthcare worker to perform a complete physical examination on patients presenting to them was important. Clinical officers demonstrated the procedures utilized to perform a physical exam that included the determination of the patients' blood pressure, measurement of weight and waist circumference and examination of the feet. However, 73.2% of clinical officers determined the patients' weight circumference (P=0.034). Overall, there was a significant variation (P=0.001) in the proportion of clinical officers who recorded complete physical examination and were able to appropriately manage HTN&T2DM as opposed to those who did not do a thorough clinical examination. A detailed clinical history is crucial in making an appropriate clinical diagnosis (Swash and Hutchison 2002). There is no comparable study on the ability to perform a physical examination; however, it is recommended that it forms part of the diagnosis process (NAS and Medicine 2016). These results were in tandem with a binary regression modelling that revealed that inability to perform a complete physical examination was significantly associated (P=0.009) with the

clinical officers' inability to appropriately manage patients presenting with HTN&T2DM. Collectively, these results point to the fact that the knowledge and ability to perform a complete physical examination is an important indicator of whether a clinical officer can or cannot appropriately manage patients with HTN&T2DM. Determination of patient target ranges for body mass index (BMI) is important for the management of patients with HTN&T2DM. It is known from the literature that overweight and obesity are risk factor for developing HTN and DM (Caprio et al. 2007). In this study, association was seen between the ability of clinical officers to correctly calculate the right BMI or record correct target BMI values and their aprpropriateness to manage HTN&T2DM. Applying the correct procedure for determining the patient's blood pressure (BP) has been shown to help detect hypertension early in the pre-symptomatic phase. The screening technique is simple, cheap, and acceptable (Abolfotouh et al. 2011). The ability of COs to measure blood pressure correctly was investigated. Results from this study revealed no association between steps taken by COs to measure patients' blood pressure and the appropriateness to manage HTN&T2DM. These results vary from those of a previous study that demonstrated an overall good practice of primary health care physicians on blood pressure measurement (Abolfotouh et al. 2011).

The correct interpretation of laboratory and radiological results of patients presenting to local health facilities is essential in management (NAS and Medicine 2016). The study did not find any association between the clinical officers' appropriateness to manage patients with HTN&T2DM and their ability to interpret laboratory results well. The common laboratory tests done were levels of; fasting glucose, two hourly postprandial glucose and glycated (HbA1c), urine protein, cholesterol and interpretation of chest x-ray films. No association was seen between participants' appropriateness to manage HTN&T2DM and correct interpretation of any three or four laboratory tests.

5.1.3 Treatment and Follow-ups of Patients Presenting with HTN&T2DM

Once diagnosed with HTN&T2DM, patients often undergo lifelong treatment with regular follow-up sessions. This study investigated the clinical officers' knowledge of first-line medications used to manage hypertension in patients with diabetes mellitus and type 2 diabetes mellitus. The recommended first-line drugs for hypertension in diabetes mellitus are Angiotensin Converting Enzyme Inhibitors (ACEI) (Cooper et al. 2007; Lastra et al. 2008), while stable type 2 diabetes mellitus is effectively managed with metformin (Inzucchi et al. 2015). The results presented here revealed that Clinical officers who recommended a correct drug for the management of hypertension or Type 2 diabetes mellitus were more likely to appropriately manage patients presenting with poor HTN&T2DM. These results correlate well with the observation that 39.0% of participants who prescribed ACEIs for patients with hypertension alone and 17.1% of participants who prescribed metformin for patients with diabetes mellitus alone, were able to manage patients with both HTN&T2DM appropriately. A systematic review of task- shifting on Non-Communicable disease management in Low- and Middle-Income counties showed that the main barriers to proper management of patients were inappropriate prescriptions and lack of availability of medications (Joshi et al. 2014).

The standard procedure for management of pre-hypertensive patients involves advice on lifestyle modification (Cutler 1993), such as reduced alcohol intake (Puddey et al. 1992), reduced sodium chloride intake (Sacks et al. 2001), increased physical activity (Arroll and Beaglehole 1992), and control of weight (Stevens et al. 1993). This additional knowledge on the management of patients with pre-hypertension may significantly reduce the risk of progression to hypertension and diabetes mellitus (Horr and Nissen 2016). Effective management of patients with pre-hypertension is to engage in non-pharmacological life modification strategies fully (Chalmers and Zanchetti 1996; Strasser 1995; Whelton 1994). The results presented here showed a significant variation (P=0.001) in the distribution of

participants' responses to strategies of managing pre-hypertension. Three quarters (75.6%) of Clinical officers were able to manage patients with HTN&T2DM, stressing non-pharmacological lifestyle modifications measures. Further regression analyses demonstrated that Clinical officers who recommended a combination of anti-hypertensive medication and lifestyle modification were highly likely (P=0.002) to manage patients with HTN&T2DM more appropriately compared to their colleagues who stressed on pharmacological methods alone. It is evident that multiple lifestyle modifications are beneficial in promoting improved outcomes for diabetes and hypertension patients' management. Previous study has also suggested that patient follow up involvement; cultural adaptation, family involvement and individualization are important factors in the development of interventions seeking to increase program-management among patients with diabetes (Young, 2015).

Patients with HTN&T2DM require close monitoring (MOH 2015). It is, therefore, crucial for health-care facilities and health-care professionals to schedule patients for regular follow-up clinics. This study investigated various aspects of patient follow-up such as; the ability of Clinical officers to follow up their patients, the presence of scheduled clinic days for HTN&T2DM patients, assignment of specific staff to handle follow-up patients, allocation of dedicated space for follow-up patients with HTN&T2DM. There was no significant association between the clinical officers' ability to adequately care for these patients (P=0.796), allocation of special clinic day for patients (P=0.129), dedicated assigned staff to these patients (P=0.207) and a dedicated room for reviewing these patients (P=0.657). This scenario probably accounted for the health facilities being associated with increased ability (P<0.001) of Clinical officers to manage patients presenting with HTN&T2DM well. These results suggest that effective management of HTN&T2DM at a health facility requires the presence of a clear patient follow-up strategy that would include; tracking of patients through planned clinic days, availability of staff and dedicated rooms for patients with HTN&T2DM.

A common complication in patients presenting with HTN&T2DM is eye-related problems (Tumosa 2008). This study investigated eye checkup schedules as proposed by study participants. The results revealed no association between Clinical officers' ability to manage HTN&T2DM well and scheduled eye checkups; this may be a paradox, though it is difficult to explain the findings. Furthermore, a literature review on follow up patient education with emphasis on methods and effects concluded that the existing knowledge in patient education is insufficiently due to inadequate followup programs (WHO, 2010). Further understanding of how follow up program-management intervention supports the patient in dealing with diabetes in everyday life is also imperative for implementation of diabetes and hypertension treatment aiming at improving and maintaining follow up-care activities (WHO and HAI, 2015).

5.1.4 Equipment and National Guidelines Utilized in Management of HTN&T2DM

Management of patients with HTN&T2DM relies on the use of various equipments for diagnosis and monitoring of patients. The results presented here showed no association between the ability of Clinical officers to correctly identify relevant diagnostic equipment or demonstrate their use and their ability to manage HTN&T2DM. Lack of access to appropriate diagnostic equipment was associated with poor management of HTN&T2DM (P=0.089); however, it was not statistically significant. The most available diagnostic equipment was a stethoscope, and this is far from the WHO recommendation on the six-essential technologies for the management of HTN&T2DM. These results compare well with those of a previous study that investigated the gaps in capacity in primary care in low-resource settings for NCDs. The study observed that the most available equipment was a weighing scale in 99.0% of the centres, a tape measure in 63.0% of the centres and a blood pressure machine in 10% (Mendis et al. 2012). The six-essential technologies include blood pressure measurement device, weighing scales, height measuring equipment, blood glucose and blood cholesterol

measurement devices with strips, and urine strips for albumin assay (WHO 2013b). Even though a pen torch and an ophthalmoscope are not included in the essential technology list as described by WHO, they are crucial to the management of common eye complication for patients presenting with HTN&T2DM (Tumosa 2008). It is therefore essential that this ophthalmological equipment be included in the essential technology list. There is limited data on the level of accessibility of these essential tools by Clinical officers or other primary care physicians in the rural healthcare facilities.

World Health Organization has developed guidelines for the management of HTN&T2DM patients (WHO 2002), and Kenya has domesticated these protocols in health facilities across the country (MOH 2018). We investigated the availability and usage of national guidelines, and the impact on the treatment of HTN&T2DM in the study sites. The results demonstrated that inaccessibility to the guidelines impacted negatively on the management of the various conditions. In the management of hypertension, it was $P<0.001$, in diabetes mellitus it was $P<0.001$, and in heart failure, it was $P=0.034$ (Table 25). Further binary regression analyses revealed that absence of guidelines was associated with the inability of the clinical officers to manage the following conditions; for hypertension $P<0.001$, for diabetes mellitus $P<0.001$ and heart failure $P=0.083$. Results presented here were similar to those observed in a study by Alebiosu (Alebiosu 2009). Other studies have also reported that availability and use of guidelines enabled successful task shifting of management of patients with HTN&T2DM by clinical officers (Some et al. 2016). These results suggest the need to provide treatment guidelines to all Clinical officers and by extension other healthcare workers in rural health facilities. These healthcare facilities instructively form the first-line interaction point for patients with HTN&T2DM. The results compare with findings and recommendations from a recent study, which indicated that making available and usage of relevant protocols by Primary Health Care workers improves performance in clinical care (Abolfotouh et al. 2011).

5.2 Conclusion

5.2.1 Summary of findings

A total number of 146 [63 female (43.2%) and 83 males (56.8%)] Clinical Officers spread out in 56 public health facilities we recruited into the study. Overall, the results presented showed that training in both hypertension and type 2 diabetes mellitus (OR=2.525, 95% CI; 0.708-9.006, P=0.153), knowledge of predisposing risk factors to HTN&T2DM (OR=9.256; 95% CI: 3.936-21.768; *P*<0.001) capacity to perform a complete physical examination on HTN&T2DM patients (OR=18.111, 95 CI; 1.433-228.884, *P*=0.025), ability to identify first-line medication for treatment of hypertension (OR=2.116, 95% CI; 0.968-4.628, *P*=0.060) or type 2 diabetes mellitus (OR=5.250, 95% CI; 1.376-20.036, *P*=0.015), availability of assigned patient follow-up clinic day, staff and dedicated room/section (OR, 18.627; 95% CI, 3.902-88.912; *P*<0.001) and availability of treatment guidelines for the management of hypertension (OR, 21.339; 95% CI, 8.197-55.863; *P*<0.001) and diabetes mellitus (OR, 5.443; 95% CI, 2.290-12.934; *P*<0.001), simultaneous prescription anti-hypertension medication and advice on lifestyle modification strategies (OR, 10.305; 95% CI, 1.059-100.290; *P*=0.044) were all associated with the appriopriate management of patients presenting with HTN&T2DM by clinical officers.

5.2.2 Conclusion

In conclusion, the study showed that:

1. Clinical Officers had inadequate knowledge to identify risk factors for developing hypertension and type 2 diabetes mellitus. Although majority of clinical officers identified atleast three of ten risk factors, non identified more than five of ten risk factors.

2. Clinical officers had inadequate skills to perform a complete physical examination for HTN&T2DM patients. They demonstrated appropriate procedure to measure blood pressure and were able to perfom waist circumference measurement.
3. Clinical officers had adequate knowledge to interpret appropriate target levels for fasting blood glucose and two-hour post prandial glucose levels. However they were not sure of the correct targets and normal interpretation for urine albumin, glycated hemoglobin A1C, total cholestral, Chest x ray and ECG strip reading
4. Failure to identify first-line treatment drugs for hypertension and diabetes mellitus was associated with inappropriate management of these patients. Majority of clinical officers prescribed inappropriate first line medicines for both T2DM and HTN in DM patients.
5. There was no deliberate revisit schedule and no dedicated staff and space to run the follow-up clinics for patients with HTN &T2DM.
6. Clinical officers had inadequate diagnostic equipments, protocols, guidelines and risk prediction charts within their reach for adequate care of HTN&T2DM.

5.3 Recommendations

1. Provide clinical guidelines/protocols and risk prediction charts, to improve on clinical perfomamce on risk assessment, physical examination and appropriate treatment of patients with Hypertension and Type 2 Diabetes Mellitus.
2. Deliberate efforts to be made to have structured follow-up clinics for patients with hypertension and diabetes mellitus. Provision of space/room, specified staff to review these patients and specific week day/s for revisits to all healthcare facilities is key to improve prefomance and care.

3. Clinical diagnostic equipments be made available to Clinical officers at all centers where they work in effort to improve care for patients with hypertsnsion and type 2 diabetes mellitus.

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APPENDICES

Appendix 1 Participants Consent Form

Dear participant,

I am a student at Maseno University, pursuing degree in Master of Medicine in Family and Emergence medicine. As part of the requirements for the award of the degree, I am conducting study to determine the challenges COs face to care for patients with NCDs in rural health facilities in Kisumu County. You are being asked to take part in a research study because you are a registered clinical officer practicing in Kisumu County. Please read this form carefully and ask any questions you may have before agreeing to take part in the study.

Purpose of study: The proposed study aims to investigate the COs capabilities to care for NCD patients in Kisumu county. Specifically, the study will investigate the COs capabilities to diagnose as well as determine barriers to Best Practice protocols and/or procedures and document training trends and resource availability for the management of diabetes mellitus, hypertension, stroke, heart failure, acute and chronic kidney disease and chronic respiratory diseases in Kisumu County in Western Kenya.

Field procedure: If you agree to be in this study, we will conduct an interview with you. The interview will include questions about your job experience, training trends and availability of diagnostic equipment.

Risks and benefits: Study will be non- invasive, and I do not anticipate any risks to you participating in this study other than those encountered in day- to-day life. Participants may also benefit from knowing that they are participating in an assessment project that will inform efforts to improve health care.

Confidentiality: The records of this study will be kept private. In any sort of report, we make public we will not include any information that will make it possible to identify you. Research records will be kept in a locked file; only the researcher will have access to the records.

Taking part is voluntary: Taking part in this study is completely voluntary. You may skip any questions that you do not want to answer. If you decide not to take part or to skip some of the questions, it will not affect your current employment. If you decide to take part, you are free to withdraw at any time.

Principle researcher contacts: The researcher conducting this study is David Ikura Shivachi, P.O Box 7799 Kisumu. Tel 0721473978, email address:ikurars@yahoo.com. you may contact him for any question or clarification

For any query about the study, you may contact National Ethical Review Committee P.O Box54840, Nairobi. Tel. (02) 02722541.

You will be given a copy of this form to keep for your records.

Statement of Consent: I have read the above information and have received answers to any questions I asked. I consent to take part in the study.

Your Signature _____ Date _____

Your Name _____

Signature of person obtaining consent _____ Date _____

Name of person obtaining consent _____ Date _____

Appendix 2 Time Schedule

ACTIVITY	TIME PERIOD								
	FEB 2017	MA 2017	APR 2017	MAY 2017	JUN 2017	JUL 2017	JAN 2018	FEB 2018	JUL 2018
Proposal Development									
Supervisor Reviews									
Proposal Defense/Approval									
Pilot Testing									
Data Collection and Collation/Entry									
Data Analysis and Preliminary Report Thesis defense									

Appendix 3 Budget

SNO	DESCRIPTION	QUANTITY	COST PER ITEM (KSH).	TOTAL (KSH.)
1.	Field assistants	3	2000	6000
2.	Fuel		25000	25000
3.	Training of research assistants		2000	12000
4.	Binding costs	12	500	6000
5.	Stationery	Assorted	Assorted	5000
6.	Questionnaire pilot	1	10000	10000
7.	Research assistants	3	5500	16,500
8.	Printing services		5000	5000
9.	Lunch	56 days	250	14000
TOTAL				99500

Appendix 4 List of public healthcare facilities with clinical officers in Kisumu County

HEALTH FACILITY NAME	NO. OF CLINICAL OFFICERS	SUB COUNTY
Migosi Sub-County Hospital	6	Kisumu central
Kisumu County Referral Hospital	44	Kisumu Central
Railways Health Centre	3	Kisumu Central
Pandipieri Dispensary	1	Kisumu Central
Kowino Dispensary	2	Kisumu Central
Admini. Police Line Dispensary	1	Kisumu Central
Nyalenda Health Centre	1	Kisumu Central
Jaramogi Oginga Odinga T.R. Hospital	61	Kisumu Central
Lumumba Sub-County Hospital	18	Kisumu Central
Got Nyabondo Health Centre	1	Kisumu East
Simba Opepo Health Centre	1	Kisumu East
Gita Sub-County Hospital	2	Kisumu East
Nyalunya Health Centre	1	Kisumu East
GK (Kibos) Prisons Dispensary	1	Kisumu East
Orongo Dispensary	1	Kisumu East
Chiga Dispensary	2	Kisumu East
Kuoyo Health Centre	1	Kisumu East
Airport Health Centre	1	Kisumu West
Kodiaga Prison Health Centre	2	Kisumu West
St. Marks Lela Health Centre	1	Kisumu West
Nyahera Sub-County Hospital	5	Kisumu West
Siriba Dispensary	1	Kisumu West
Chulaimbo Sub-County Hospital	15	Kisumu West
Riat Health Centre	1	Kisumu West
Ober Kamoth Dispensary	2	Kisumu West
Ojola Dispensary	1	Kisumu West
Riat Dispensary	1	Kisumu West
LwalaKadawa Health Centre	1	Kisumu West
Kombewa County Hospital	10	Seme
Lolwe Dispensary	1	Seme
Kuoyo Kaila Health Centre	1	Seme

HEALTH FACILITY NAME	NO. OF CLINICAL OFFICERS	SUB COUNTY
Langi Kawino Dispensary	2	Seme
Rodi Dispensary	2	Seme
Miranga Health Centre	3	Seme
Bochi Health Centre	1	Seme
Korwenje Dispensary	1	Seme
NduruKadero Health Centre	1	Seme
Opapla Dispensary	1	Seme
Otieno Owala Memorial Health Centre	1	Seme
Ratta Health Centre	2	Seme
Arito Langi Health Centre	2	Seme
Manyuanda Dispensary	3	Seme
Bodi Dispensary	1	Seme
Kibigori Health Centre	2	Muhoroni
Tamu Health Centre	2	Muhoroni
Ogen Dispensary	1	Muhoroni
Mashambani Dispensary	1	Muhoroni
Kasongo Dispensary	1	Muhoroni
Muhoroni County Hospital	5	Muhoroni
Jaber Dispensary	1	Muhoroni
Kandege Dispensary	2	Muhoroni
Koru Dispensary	2	Muhoroni
Mnara Dispensary	1	Muhoroni
Miwani Health Centre	1	Muhoroni
Chemelil GOK Health Centre	5	Muhoroni
Agro chemical Dispensary	2	Muhoroni
Nyang'oma Sub-County Hospital	5	Muhoroni
Masogo Sub-County Hospital	4	Muhoroni
Obumba / Yawo Dispensary	1	Muhoroni
Nyakach County Hospital	6	Nyakach
Bonde Dispensary	2	Nyakach
Pedo Dispensary	2	Nyakach
Kibogo Dispensary	2	Nyakach

HEALTH FACILITY NAME	NO. OF CLINICAL OFFICERS	SUB COUNTY
Katito Sub-County Hospital	3	Nyakach
Radienya Health Centre	2	Nyakach
Sigoti Health Centre	2	Nyakach
Sondu Sub-County Hospital	4	Nyakach
Oboch Dispensary	1	Nyakach
Anding'oOpanga Health Centre	2	Nyakach
Nyamarimba Sub-County Hospital	3	Nyakach
Sango Rota Health Centre	2	Nyakach
Kusa Health Centre	2	Nyakach
Bunde Health Centre	1	Nyando
Ahero County Hospital	8	Nyando
Holo Dispensary	1	Nyando
Wang'anga Health Centre	2	Nyando
KatoloManyatta Health Centre	1	Nyando
KinasiaHealth Centre	2	Nyando
Magina Health Centre	1	Nyando
Nyakongo Health Centre	1	Nyando
Kanyagwal Dispensary	2	Nyando
Nyangande Sub-County Hospital	4	Nyando
Okana Dispensary	1	Nyando
HongoOgosa Health Centre	2	Nyando
Rabuor Sub-County Hospital	6	Nyando

Appendix 5 Questionnaire

Questionnaires ID#:
Study Area
Hospital name:
Sub-county:
Hospital level: County [ ] Sub-County [ ] health centre [ ] Dispensary [ ]

1. Basic Characteristics Respondent

1. Which clinical department are you placed in this hospital?
   General OPD [ ] MCH [ ] HIV [ ] in patient [ ] NCD [ ] Others [ ]
2. How long have you been in service after internship?
   <10 yrs [ ] > 10yrs [ ]
3. Gender of respondent Male [ ] Female [ ]
4. Employer County Government [ ] support partners [ ]

5. A) Apart from diploma in clinical medicine, have you had any other formal post basic course?
   Yes [ ] No [ ]
   B) If yes what qualification level and specific course done?
   Certificate(s) [ ] diploma [ ] Higher diploma [ ] degree [ ] masters degree [ ]

2. Knowledge on Diabetes and Hypertension diagnosis, management and referral

A. History taking & diagnosis

6. In this clinic, can you make a diagnosis of hypertension or diabetes?
   Yes [ ] No [ ]
7. What information do you enquire from clients you suspect to have hypertension and diabetes type 2 to assess for risk factors?

B. Interpretation of basic results

8. Interpret the provided result and What are the normal values for the following tests in diabetes and hypertension
   a. Capillary blood glucose values (finger -prick)
      Fasting
      ----------mmol/l [ ] not sure [ ]
      2hours-post – prandial glucose level
      ---------- mmol/l [ ] not sure [ ]
   b. Glycated haemoglobin (HbA1C)
      ----------% [ ] not sure [ ]
   c. Dipstick for microalbuminuria /proteinuria
      ----------units [ ] not sure [ ]
   d. Total cholesterol
      ----------mmol/l [ ] not sure [ ]
   e. Chest x-ray cardiothoracic ratio (CTR)
      ---------- Ratio [ ] not sure [ ]
   f. Electro-cardiograph strip rhythm reading with
      ---------- Rhythm [ ] [ ] not sure

C. Basic examination

9. Demonstrate how you evaluate your patients presenting with diabetes mellitus in this clinic on this client.
   B.P measurement [ ] Weight [ ] Waist circumference [ ] Examined the feet [ ]

10. How do you calculate BMI for your patients in this clinic?
    ----------formula [ ] not sure [ ]
11. What is your normal BMI targets in diabetic and Hypertensive patients
    ---------- Range [ ] Not sure
12. Demonstrate on how you check for blood pressure of your client in this clinic on this client
    a) Explained to the patient to have rested at least 5min Yes [ ] No [ ]
    b) Rest the arm at the level of the heart Yes [ ] No [ ]
    c) Deflate the cuff to Zero (0) reading Yes [ ] No [ ]
    d) Apply cuff in contact with skin Yes [ ] No [ ]
    e) Cuff to fit the upper arm at least 80% Yes [ ] No [ ]
    f) Take the first reading and document Yes [ ] No [ ]
    g) Repeat after 5min Yes [ ] No [ ]

D. Basic treatment protocols

13. Which medicines do you prescribe for a stable obese diabetic patient presenting for the first time
    ---------- [ ] not sure [ ]
14. Which medicine or class of medicines would you prescribe for hypertension in a diabetic patient presenting for the first time?
    ---------- [ ] Not sure [ ]
15. How would manage a patient presenting for the first time with BP of 139/90 mmHg

Antihypertensives [ ] lifestyle modification [ ] medicines & lifestyle modification [ ] not sure [ ]

16. For the patients attending this clinic what life modification activities do you advice your clients with hypertension.

E. Follow up and referral.

17. Are you able to admit/ follow up Diabetes and Hypertensive patients at this facility? (if yes, answer question 18 and if No, answer question 19.
    Yes [ ] No. [ ]
18. If Yes,

a. Do you have specific day for review of this patient?
    Yes [ ] No [ ]

b. Is their assigned staff to review these patients?
    Yes [ ] No [ ]

c. Is there a specified room/ space where these patients are reviewed from?
    Yes [ ] No [ ]

19. In the patients you follow up for hypertension and diabetes, how often do you advice them for eye check up?
    ---------- [ ] not sure [ ]

3. Availability and use of equipment's

20. Can you identify these clinical equipments and show how to use them?
    a. Stethoscope yes [ ] No [ ] know how to use [ ] don't know how [ ]
    b. Patella hammer yes [ ] No [ ] know how to use [ ] don't know how [ ]
    c. Weighing Scale yes [ ] No [ ] know how to use [ ] don't know how [ ]

d. Pen touch yes [ ] No [ ] know how to use [ ] don't know how [ ]
e. Ophthalmoscope yes [ ] No [ ] know how to use [ ] don't know how [ ]
f. Tape measure yes [ ] No [ ] know how to use [ ] don't know how [ ]
g. Tuning fork yes [ ] No [ ] know how to use [ ] don't know how [ ]
h. Sphygmomanometer Yes [ ] No [ ] know how to use [ ] don't know how[ ]
i. Glucometer Yes [ ] No [ ] know how to use [ ] don't know how [ ]

21. Do you have the following equipments with you in this clinic?
    a. Stethoscope yes [ ] No [ ]
    b. Patella hammer yes [ ] No [ ]
    c. Weighing Scale yes [ ] No [ ]
    d. Pen touch yes [ ] No [ ]
    e. Ophthalmoscope yes [ ] No [ ]
    f. Tape measure yes [ ] No [ ]
    g. Tuning fork yes [ ] No [ ]
    h. Sphygmomanometer Yes [ ] No [ ]
    i. Glucometer Yes [ ] No [ ]

22. Do you have a National Guidelines/ protocols to manage the following conditions? Are they useful?
    1. Hypertension yes [ ] No. [ ]
    2. Diabetes mellitus yes [ ] No. [ ]
    3. Heart failure yes [ ] No. [ ]
    4. Ischemic Stroke yes [ ] No. [ ]
    5. Renal disease yes [ ] No. [ ]

Appendix 6 Scoring Template and Outcome

Diagnosis				Treatment				FOLLOW UP				Ava. score
History	Physical Exam	Lab	100 (T1)	Pre-HTN	T2DM	HTN	100(T2)	Scheduled day	assigned staff	Room	100 (T3)	(T1+T2+T3)/3
5	3	2	**47.6**	33.3	33.3	33.3	**100.0**	0.0	33.3	33.3	**66.7**	71.4
5	2	1	**38.0**	33.3	0.0	0.0	**33.3**	33.3	0.0	0.0	**33.3**	34.9
5	2	4	**53.4**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	28.9
1	3	4	**38.0**	0.0	0.0	0.0	**0.0**	33.3	0.0	0.0	**33.3**	23.8
3	2	2	**33.3**	0.0	33.3	0.0	**33.3**	0.0	0.0	0.0	**0.0**	22.2
2	2	1	**23.8**	33.3	0.0	0.0	**33.3**	0.0	33.3	33.3	**66.7**	41.3
4	3	6	**61.9**	33.3	0.0	0.0	**33.3**	0.0	33.3	33.3	**66.7**	54.0
3	2	1	**28.6**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	20.6
1	2	1	**19.0**	0.0	0.0	0.0	**0.0**	33.3	33.3	33.3	**100.0**	39.7
4	3	3	**47.6**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	27.0
5	3	2	**47.6**	33.3	0.0	33.3	**66.7**	0.0	0.0	0.0	**0.0**	38.1
1	2	3	**28.6**	33.3	0.0	0.0	**33.3**	33.3	33.3	33.3	**100.0**	54.0
4	1	3	**38.0**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	23.8
4	2	4	**47.6**	33.3	0.0	33.3	**66.7**	33.3	0.0	0.0	**33.3**	49.2
3	1	6	**47.6**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	27.0
1	3	4	**38.0**	33.3	0.0	33.3	**66.7**	0.0	0.0	0.0	**0.0**	34.9
1	2	4	**33.3**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	22.2
2	1	5	**38.0**	33.3	33.3	33.3	**100.0**	33.3	0.0	33.3	**66.7**	68.2
1	3	5	**42.8**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	25.4
3	2	1	**28.6**	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**	9.5
4	2	4	**47.6**	33.3	0.0	0.0	**33.3**	33.3	0.0	0.0	**33.3**	38.1
4	1	5	**47.6**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	27.0
3	1	0	**19.0**	33.3	0.0	0.0	**33.3**	33.3	33.3	33.3	**100.0**	50.8
5	1	3	**42.8**	33.3	0.0	33.3	**66.7**	0.0	0.0	0.0	**0.0**	36.5
5	3	2	**47.6**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	27.0
3	1	1	**23.8**	33.3	33.3	0.0	**66.7**	0.0	0.0	0.0	**0.0**	30.2
3	1	5	**42.8**	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**	14.3
3	1	4	**38.0**	33.3	0.0	33.3	**66.7**	0.0	0.0	0.0	**0.0**	34.9
3	3	6	**57.1**	33.3	0.0	0.0	**33.3**	33.3	0.0	33.3	**66.7**	52.4
3	3	6	**57.1**	0.0	33.3	33.3	**66.7**	0.0	0.0	0.0	**0.0**	41.3
2	1	4	**33.3**	33.3	0.0	0.0	**33.3**	33.3	0.0	0.0	**33.3**	33.3
3	3	1	**33.3**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	22.2
3	3	3	**42.8**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	25.4
1	3	5	**42.8**	0.0	0.0	0.0	**0.0**	33.3	0.0	0.0	**33.3**	25.4
5	1	5	**53.4**	0.0	33.3	0.0	**33.3**	0.0	0.0	0.0	**0.0**	28.9

Diagnosis				Treatment				FOLLOW UP				Ava. score
3	2	4	**42.8**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	25.4
6	1	0	**33.3**	33.3	33.3	0.0	**66.7**	0.0	0.0	0.0	**0.0**	33.3
3	3	5	**53.4**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	28.9
6	2	2	**52.4**	0.0	33.3	0.0	**33.3**	33.3	0.0	33.3	**66.7**	50.8
3	2	1	**28.6**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	20.6
4	2	1	**33.3**	33.3	0.0	0.0	**33.3**	33.3	0.0	0.0	**33.3**	33.3
3	2	2	**33.3**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	22.2
4	2	4	**47.6**	33.3	0.0	0.0	**33.3**	33.3	0.0	0.0	**33.3**	38.1
3	3	3	**42.8**	33.3	0.0	0.0	**33.3**	33.3	33.3	0.0	**66.7**	47.6
4	3	4	**53.4**	33.3	0.0	33.3	**66.7**	0.0	0.0	0.0	**0.0**	40.0
5	3	0	**38.0**	33.3	33.3	0.0	**66.7**	0.0	0.0	0.0	**0.0**	34.9
5	2	2	**52.4**	33.3	0.0	0.0	**33.3**	33.3	33.3	0.0	**66.7**	50.8
5	2	3	**47.6**	33.3	0.0	33.3	**66.7**	0.0	0.0	0.0	**0.0**	38.1
1	3	5	**42.8**	33.3	0.0	0.0	**33.3**	33.3	0.0	0.0	**33.3**	36.5
2	2	2	**28.6**	33.3	33.3	33.3	**100.0**	0.0	0.0	33.3	**33.3**	54.0
1	1	4	**28.6**	33.3	0.0	0.0	**33.3**	33.3	33.3	33.3	**100.0**	54.0
2	2	2	**28.6**	33.3	33.3	0.0	**66.7**	0.0	33.3	33.3	**66.7**	54.0
3	3	6	**57.1**	33.3	0.0	0.0	**33.3**	0.0	33.3	33.3	**66.7**	52.4
4	2	1	**33.3**	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**	11.1
2	2	2	**28.6**	33.3	0.0	0.0	**33.3**	33.3	33.3	33.3	**100.0**	54.0
4	3	3	**47.6**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	27.0
4	3	2	**23.8**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	19.0
1	2	3	**28.6**	33.3	0.0	33.3	**66.7**	33.3	33.3	33.3	**100.0**	65.1
3	3	0	**28.6**	0.0	0.0	0.0	**0.0**	33.3	33.3	0.0	**66.7**	31.8
4	1	2	**33.3**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	22.2
1	2	4	**33.3**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	22.2
3	1	6	**28.6**	33.3	33.3	0.0	**66.7**	0.0	0.0	0.0	**0.0**	31.8
1	3	4	**23.8**	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**	7.9
1	2	4	**14.3**	33.3	0.0	33.3	**66.7**	0.0	0.0	0.0	**0.0**	27.0
2	1	4	**33.3**	33.3	33.3	0.0	**66.7**	33.3	0.0	33.3	**66.7**	55.5
1	3	5	**42.8**	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**	14.3
3	1	3	**33.3**	33.3	0.0	33.3	**66.7**	0.0	33.3	0.0	**33.3**	44.4
3	2	1	**28.6**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	20.6
3	2	3	**38.0**	33.3	33.3	33.3	**100.0**	33.3	0.0	0.0	**33.3**	57.1
4	1	4	**42.8**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	25.4
4	1	0	**23.8**	33.3	33.3	0.0	**66.7**	33.3	33.3	33.3	**100.0**	63.5
5	1	3	**42.8**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	25.4
4	3	2	**42.8**	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**	14.3
3	1	0	**19.0**	0.0	33.3	0.0	**33.3**	0.0	0.0	0.0	**0.0**	17.4

Diagnosis				**Treatment**				**FOLLOW UP**				**Ava. score**
3	1	6	**28.6**	33.3	0.0	0.0	**33.3**	33.3	33.3	33.3	**100.0**	54.0
5	1	3	**42.8**	33.3	33.3	0.0	**66.7**	33.3	0.0	0.0	**33.3**	47.6
3	1	5	**42.8**	0.0	33.3	0.0	**33.3**	0.0	0.0	0.0	**0.0**	25.4
2	1	4	**33.3**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	22.2
5	3	6	**66.7**	0.0	33.3	0.0	**33.3**	33.3	0.0	33.3	**66.7**	55.6
3	3	6	**57.1**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	30.1
2	1	4	**33.3**	33.3	0.0	0.0	**33.3**	33.3	0.0	0.0	**33.3**	33.3
3	3	1	**33.3**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	22.2
3	3	4	**47.6**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	27.0
3	3	3	**42.8**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	25.4
5	3	5	**61.9**	33.3	0.0	33.3	**66.7**	33.3	0.0	0.0	**33.3**	54.0
4	1	5	**47.6**	33.3	33.3	0.0	**66.7**	0.0	0.0	0.0	**0.0**	38.1
3	2	4	**42.8**	0.0	33.3	0.0	**33.3**	0.0	0.0	0.0	**0.0**	25.4
5	1	0	**28.6**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	20.6
4	2	5	**53.4**	0.0	33.3	0.0	**33.3**	0.0	0.0	0.0	**0.0**	28.9
5	2	1	**38.0**	33.3	0.0	0.0	**33.3**	33.3	0.0	33.3	**66.7**	46.0
4	2	1	**33.3**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	22.2
4	2	1	**33.3**	33.3	0.0	0.0	**33.3**	33.3	0.0	0.0	**33.3**	33.3
3	2	2	**33.3**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	22.2
4	2	3	**52.4**	33.3	0.0	33.3	**66.7**	33.3	0.0	0.0	**33.3**	50.8
1	3	5	**42.8**	33.3	33.3	0.0	**66.7**	33.3	33.3	0.0	**66.7**	58.7
3	2	4	**42.8**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	25.4
4	1	0	**23.8**	33.3	0.0	33.3	**66.7**	0.0	0.0	0.0	**0.0**	30.2
4	2	5	**53.4**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	28.9
4	2	2	**38.0**	33.3	0.0	33.3	**66.7**	33.3	0.0	33.3	**66.7**	57.1
4	2	1	**33.3**	33.3	33.3	0.0	**66.7**	0.0	0.0	0.0	**0.0**	33.3
4	2	1	**33.3**	33.3	0.0	0.0	**33.3**	33.3	0.0	0.0	**33.3**	33.3
3	2	2	**33.3**	33.3	33.3	33.3	**100.0**	33.3	0.0	0.0	**33.3**	55.5
4	2	4	**47.6**	33.3	0.0	0.0	**33.3**	33.3	0.0	0.0	**33.3**	38.1
1	3	4	**38.0**	33.3	0.0	33.3	**66.7**	33.3	33.3	0.0	**66.7**	57.1
4	3	3	**47.6**	33.3	33.3	0.0	**66.7**	0.0	33.3	33.3	**66.7**	60.3
4	3	0	**33.3**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	22.2
4	2	2	**38.0**	33.3	33.3	33.3	**100.0**	33.3	33.3	0.0	**66.7**	68.2
5	2	4	**53.4**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	28.9
1	3	5	**52.4**	33.3	0.0	33.3	**66.7**	33.3	0.0	0.0	**33.3**	50.8
4	2	2	**38.0**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	23.8
1	1	4	**28.6**	33.3	0.0	0.0	**33.3**	33.3	33.3	33.3	**100.0**	54.0
2	2	1	**23.8**	33.3	0.0	0.0	**33.3**	0.0	33.3	33.3	**66.7**	41.3
3	3	6	**57.1**	33.3	0.0	0.0	**33.3**	0.0	33.3	33.3	**66.7**	52.4
3	2	1	**28.6**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	20.6
2	2	2	**28.6**	33.3	0.0	33.3	**66.7**	33.3	33.3	33.3	**100.**	65.1

Diagnosis				**Treatment**				**FOLLOW UP**				**Ava. score**
											0	
4	3	3	**47.6**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	27.0
4	2	2	**38.0**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	23.8
3	3	2	**38.0**	33.3	33.3	33.3	**100.0**	33.3	0.0	0.0	**33.3**	57.1
2	2	3	**33.3**	33.3	0.0	0.0	**33.3**	33.3	33.3	33.3	**100.0**	55.5
4	3	0	**33.3**	33.3	0.0	33.3	**66.7**	33.3	33.3	0.0	**66.7**	55.5
4	1	3	**38.0**	33.3	33.3	0.0	**66.7**	0.0	0.0	0.0	**0.0**	34.9
2	3	1	**47.7**	33.3	0.0	0.0	**33.3**	33.3	33.3	0.0	**66.7**	49.2
3	1	6	**52.4**	33.3	33.3	33.3	**100.0**	0.0	0.0	0.0	**0.0**	50.8
1	3	4	**38.0**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	23.8
1	2	4	**33.3**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	22.2
2	1	4	**33.3**	33.3	0.0	0.0	**33.3**	33.3	0.0	33.3	**66.7**	44.4
1	3	5	**42.8**	33.3	0.0	33.3	**66.7**	0.0	0.0	0.0	**0.0**	36.5
3	2	1	**28.6**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	20.6
5	3	2	**47.6**	33.3	33.3	0.0	**66.7**	0.0	33.3	33.3	**66.7**	60.3
1	2	3	**28.6**	33.3	0.0	33.3	**66.7**	33.3	33.3	33.3	**100.0**	65.1
2	3	1	**28.6**	33.3	0.0	0.0	**33.3**	33.3	33.3	0.0	**66.7**	42.9
4	1	3	**38.0**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	23.8
3	1	6	**47.6**	33.3	0.0	33.3	**66.7**	0.0	0.0	0.0	**0.0**	38.1
1	3	3	**33.3**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	22.2
1	2	4	**33.3**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	22.2
2	1	5	**38.0**	33.3	33.3	0.0	**66.7**	33.3	0.0	33.3	**66.7**	57.1
1	3	5	**42.8**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	25.4
3	1	5	**42.8**	33.3	0.0	0.0	**33.3**	0.0	0.0	0.0	**0.0**	25.4
3	2	1	**28.6**	33.3	33.3	33.3	**100.0**	0.0	33.3	0.0	**33.3**	54.0
4	2	4	**47.6**	33.3	0.0	0.0	**33.3**	33.3	0.0	0.0	**33.3**	38.1
4	1	5	**47.6**	33.3	0.0	33.3	**66.7**	0.0	0.0	0.0	**0.0**	38.1
5	1	1	**33.3**	33.3	0.0	0.0	**33.3**	33.3	33.3	33.3	**100.0**	55.5
5	1	2	**38.0**	33.3	33.3	0.0	**66.7**	0.0	0.0	0.0	**0.0**	34.9
4	3	3	**47.6**	33.3	0.0	33.3	**66.7**	0.0	0.0	0.0	**0.0**	38.1
2	1	5	**38.0**	33.3	33.3	0.0	**66.7**	33.3	0.0	33.3	**66.7**	57.1
1	3	5	**42.8**	33.3	0.0	33.3	**66.7**	0.0	0.0	0.0	**0.0**	36.5

Appendix 7 Service delivery pathway for management of cardiovascular diseases in Kenya

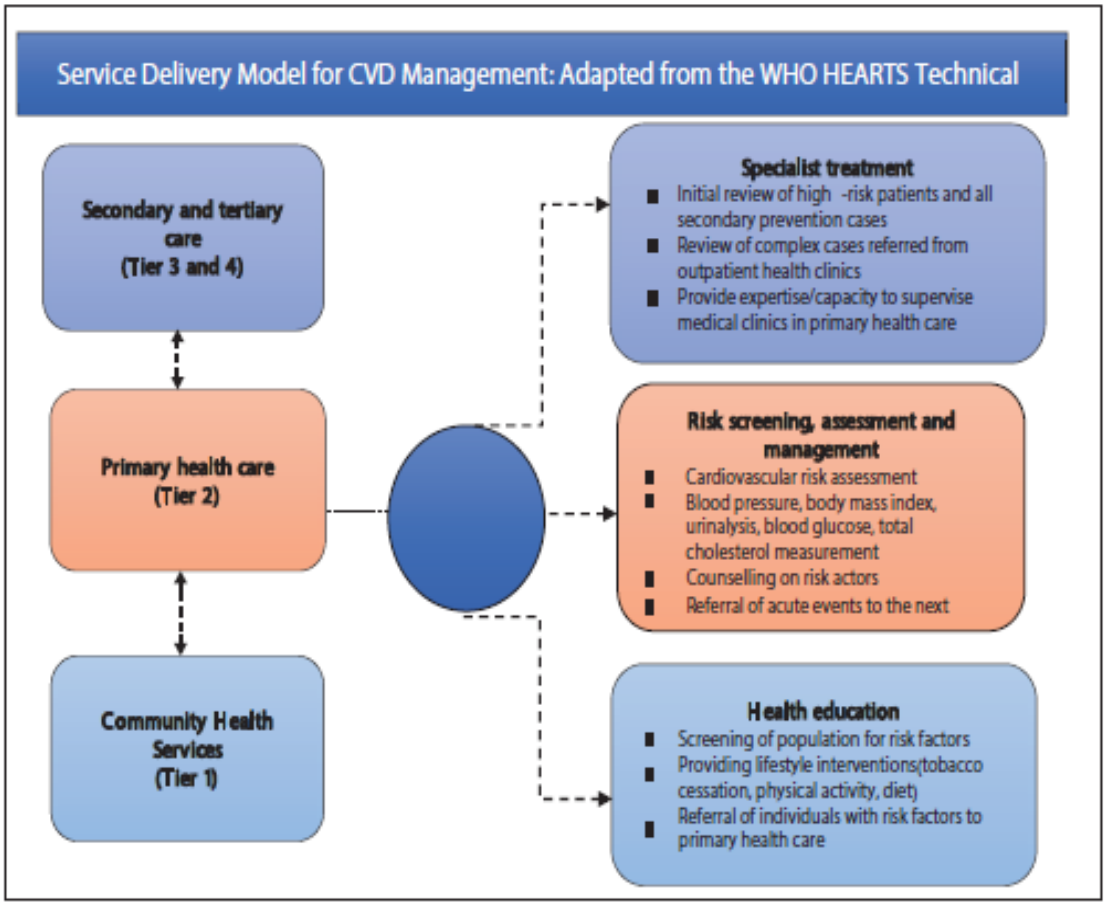


Figure 1.1 Service delivery model for CVD.

(Adapted from WHO, HEARTS Package)

Appendix 8 Recommended resources to manage Cardiovascular diseases in kenya

Table 1:1 Resources Needed for CVD Care Delivery

Resource Needed	Level 2 and 3	Level 4	Level 5 and 6
Human Resources	○ Nurses ○ Clinical officers ○ Nutritionist ○ Medical Officer ○ Lab personnel ○ Radiographers ○ Pharmacists ○ Pharmaceutical Technologists	○ Cadres in level 2 and 3 ○ Physician ○ Paediatrician ○ Echocardiographer ○ Radiologist	○ Cadres in Level 2,3,4 ○ Cardiologist ○ Pediatric Cardiologist ○ Perfusionists ○ Cardiac anaesthetists ○ Specialised nurses ○ Cardiothoracic surgeons ○ Clinical pharmacist ○ Pathologist
Diagnostic Equipment	○ BP Machine ○ Stethoscope ○ Weighing scale ○ Height meter ○ Thermometer ○ CVD risk assessment tools ○ Strips for urinalysis ○ Glucometer ○ Hematology equipement and reagents ○ Biochemistry equipment and reagents ○ X-Ray ○ ECG machine	○ Equipment in level 2 and 3 ○ Echo machine for screening ○ Biochemistry and hematological machines ○ Ophthalmoscope	○ Equipment in level 2, 3 and 4 ○ Echo machine (high specification) ○ Blood analysis: fasting blood sugar, electrolytes, creatinine, cholesterol and lipoproteins ○ Cardiac catheterisation lab ○ Ambulatory BP ○ 24 hr Holter machine ○ Treadmill ○ Facilities for telemedicine ○ A critical care unit

Medications	○ Thiazide-like* diuretic ○ Calcium-channel blocker* ○ ACEI/ARB* ○ Furosemide** ○ Statins** ○ Aspirin**	○ Diuretics (including spironolactone and furosemide) ○ Beta-blockers*** ○ Digoxin**** ○ Warfarin ○ Clopidogrel	○ Diuretics (including spironolactone and furosemide) ○ Beta blockers ○ Angiotensin converting enzyme inhibitors ○ Calcium channel blockers ○ Aspirin ○ Digoxin**** ○ Dopamine ○ Dobutamine ○ Sildenafil/tadalafil
Main Services	○ Detection ○ Diagnosis ○ Initiate treatment of uncomplicated hypertension ○ Follow-up clinic for hypertension ○ Referral	○ Services offered in level 2&3 ○ Treatment of general medical conditions Comprehensive diagnosis ○ Management of complications e.g heart failure as you prepare for referral ○ Referral ○ Rehabilitation and follow up ○ Training	○ Services offered in level 4 ○ Cardiac catheterisation and open heart surgery ○ Treatment of non-cardiac and cardiac surgical complications ○ Management of pregnancy in a cardiac patient including safe delivery

KEY: *Medications can be initiated at level 2 or 3
**Medications not to be initiated, but prescription can be refilled at level 2/3
***Beta-blockers recommended for children are propranolol and carvedilol
*****Digoxin use limited to physicians and other specialists

Appendix 9 Diagnostic Criteria for diabetes Mellitus

Diabetes may be diagnosed based on plasma glucose criteria, either the fasting plasma glucose (FPG) or the 2-hour plasma glucose (2-h PG) value after a 75-g oral glucose tolerance test (OGTT), glycosylated hemoglobin (HbA1c) criteria.

Table 2: Diagnostic criteria for Diabetes and pre-diabetes

Test	Intermediate hyperglycaemia	Diabetes
Fasting glucose	6.1-7.0 mmol/L (100-125 mg/dL)	≥7.0 mmol/L (126 mg/dL)
OR 2-hour glucose following ingestion of 75-g glucose load	7.8-11.0 mmol/L (140-199 mg/dL)	≥11.1 mmol/L (200 mg/dL)
OR random plasma glucose in symptomatic patient		≥11.1 mmol/L (200 mg/dL)
OR HbA1c		≥6.5% (48 mmol/mol)

Fasting is defined as no caloric intake for at least 8 hours.

The HbA1c test should be performed in a laboratory using a method that is NGSP-certified and standardized to the Diabetes Control and Complications Trial assay.

The 2-hour postprandial glucose test should be performed using a glucose load containing the equivalent of 75-g anhydrous glucose dissolved in water.

Source: IDF Clinical practice recommendations for managing type 2 diabetes in primary care, 2017

Appendix 10 Diagnostic cascade for type 2 Diabetes Mellitus

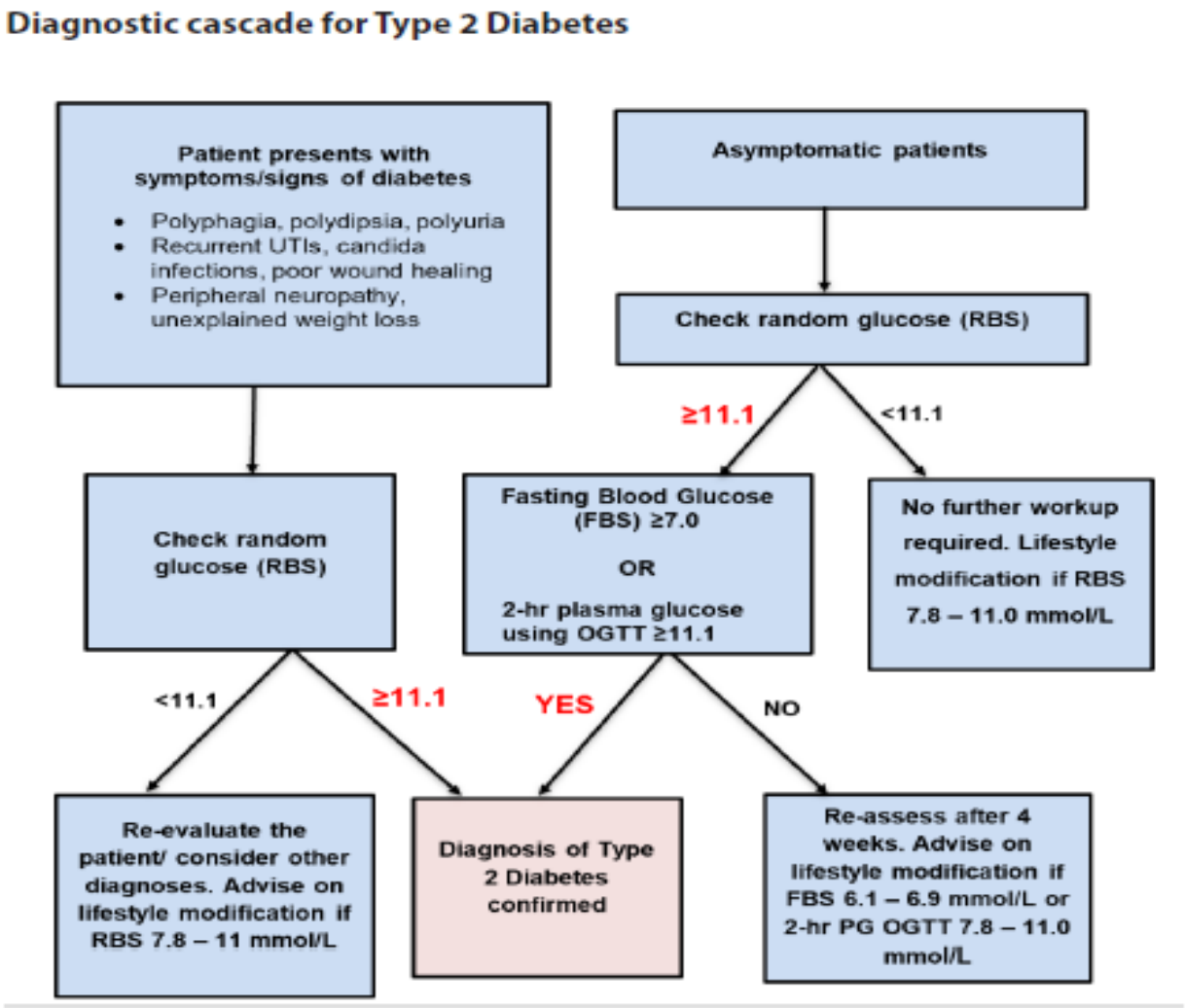
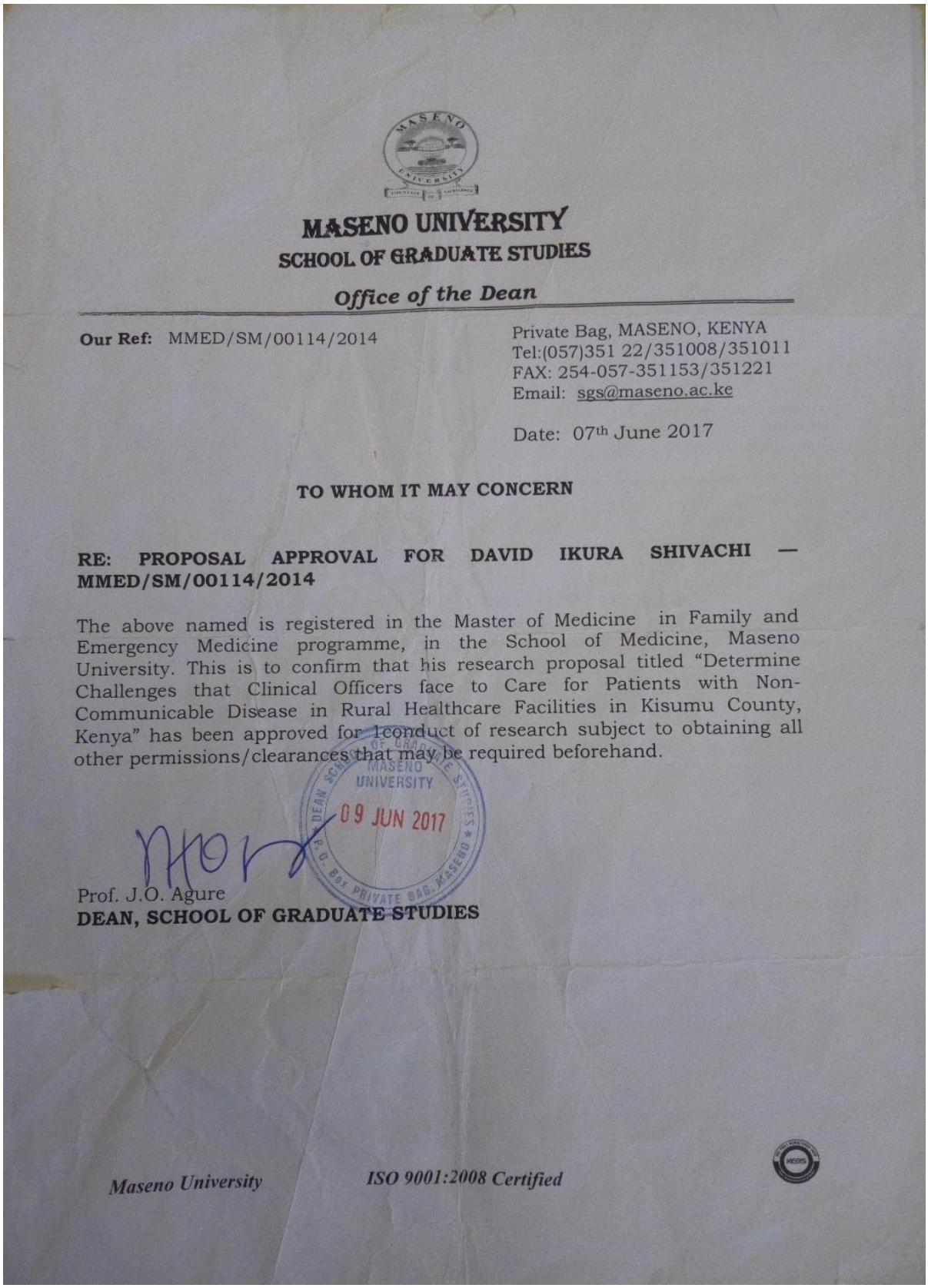


Figure 4: Diagnostic cascade for type 2 diabetes
Source: TB/DM Bidirectional screening and treatment charts, MOH, 2018

Appendix 11 Maseno university school of graduate studies approval



MASENO UNIVERSITY
SCHOOL OF GRADUATE STUDIES
Office of the Dean

Our Ref: MMED/SM/00114/2014

Private Bag, MASENO, KENYA
Tel:(057)351 22/351008/351011
FAX: 254-057-351153/351221
Email: sgs@maseno.ac.ke

Date: 07th June 2017

TO WHOM IT MAY CONCERN

RE: PROPOSAL APPROVAL FOR DAVID IKURA SHIVACHI — MMED/SM/00114/2014

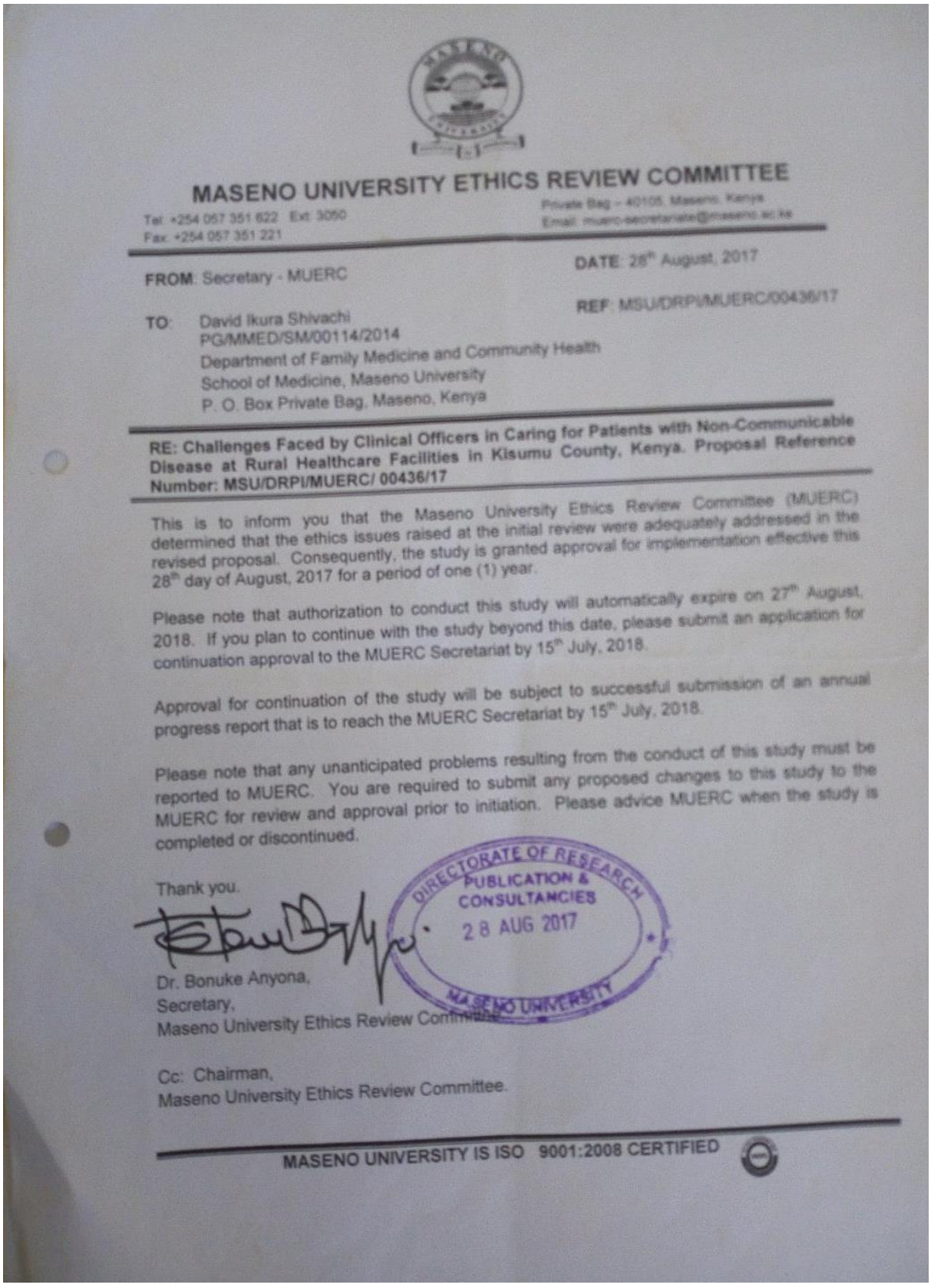
The above named is registered in the Master of Medicine in Family and Emergency Medicine programme, in the School of Medicine, Maseno University. This is to confirm that his research proposal titled "Determine Challenges that Clinical Officers face to Care for Patients with Non-Communicable Disease in Rural Healthcare Facilities in Kisumu County, Kenya" has been approved for conduct of research subject to obtaining all other permissions/clearances that may be required beforehand.

MASENO UNIVERSITY
09 JUN 2017
P.O. Box PRIVATE BAG, MASENO

Prof. J.O. Agure
DEAN, SCHOOL OF GRADUATE STUDIES

Maseno University *ISO 9001:2008 Certified*

Appendix 12 Maseno University Ethics Review committee approval



MASENO UNIVERSITY ETHICS REVIEW COMMITTEE

Tel: +254 057 351 622 Ext: 3050
Fax: +254 057 351 221

Private Bag – 40105, Maseno, Kenya
Email: muerc-secretariate@maseno.ac.ke

FROM: Secretary - MUERC

DATE: 28th August, 2017

REF: MSU/DRPI/MUERC/00436/17

TO: David Ikura Shivachi
PG/MMED/SM/00114/2014
Department of Family Medicine and Community Health
School of Medicine, Maseno University
P. O. Box Private Bag, Maseno, Kenya

RE: Challenges Faced by Clinical Officers in Caring for Patients with Non-Communicable Disease at Rural Healthcare Facilities in Kisumu County, Kenya. Proposal Reference Number: MSU/DRPI/MUERC/ 00436/17

This is to inform you that the Maseno University Ethics Review Committee (MUERC) determined that the ethics issues raised at the initial review were adequately addressed in the revised proposal. Consequently, the study is granted approval for implementation effective this 28th day of August, 2017 for a period of one (1) year.

Please note that authorization to conduct this study will automatically expire on 27th August, 2018. If you plan to continue with the study beyond this date, please submit an application for continuation approval to the MUERC Secretariat by 15th July, 2018.

Approval for continuation of the study will be subject to successful submission of an annual progress report that is to reach the MUERC Secretariat by 15th July, 2018.

Please note that any unanticipated problems resulting from the conduct of this study must be reported to MUERC. You are required to submit any proposed changes to this study to the MUERC for review and approval prior to initiation. Please advice MUERC when the study is completed or discontinued.

Thank you.

DIRECTORATE OF RESEARCH PUBLICATION & CONSULTANCIES 28 AUG 2017 MASENO UNIVERSITY

Dr. Bonuke Anyona,
Secretary,
Maseno University Ethics Review Committee

Cc: Chairman,
Maseno University Ethics Review Committee.

MASENO UNIVERSITY IS ISO 9001:2008 CERTIFIED

Appendix 13 Application letter for county health approval

DR. SHIVACHI DAVID IKURA,

MMED/SM/0114/2014,

SCHOOL OF MEDICINE,

MASENO UNIVERSITY.

2ND SEPTEMBER 2017

DIRECTOR HEALTH SERVICES,

KISUMU COUNTY

KISUMU

Dear Sir/Madam

RE: REQUEST TO COLLECT DATA IN KISUMU HEALTH FACILITIES.

Am a 3rd year student at Maseno University, pursuing Master of Medicine in Family and Emergency Medicine. Am writing my thesis on challenges faced by Clinical Officer to care for patients with non-communicable disease in rural health facilities in Kisumu County.

Following the senate approval of my thesis proposal, I kindly request your permission to allow me visit public health facilities to collect and interview clinical officers on the challenges they face to manage patients with Hypertension and Diabetes mellitus.

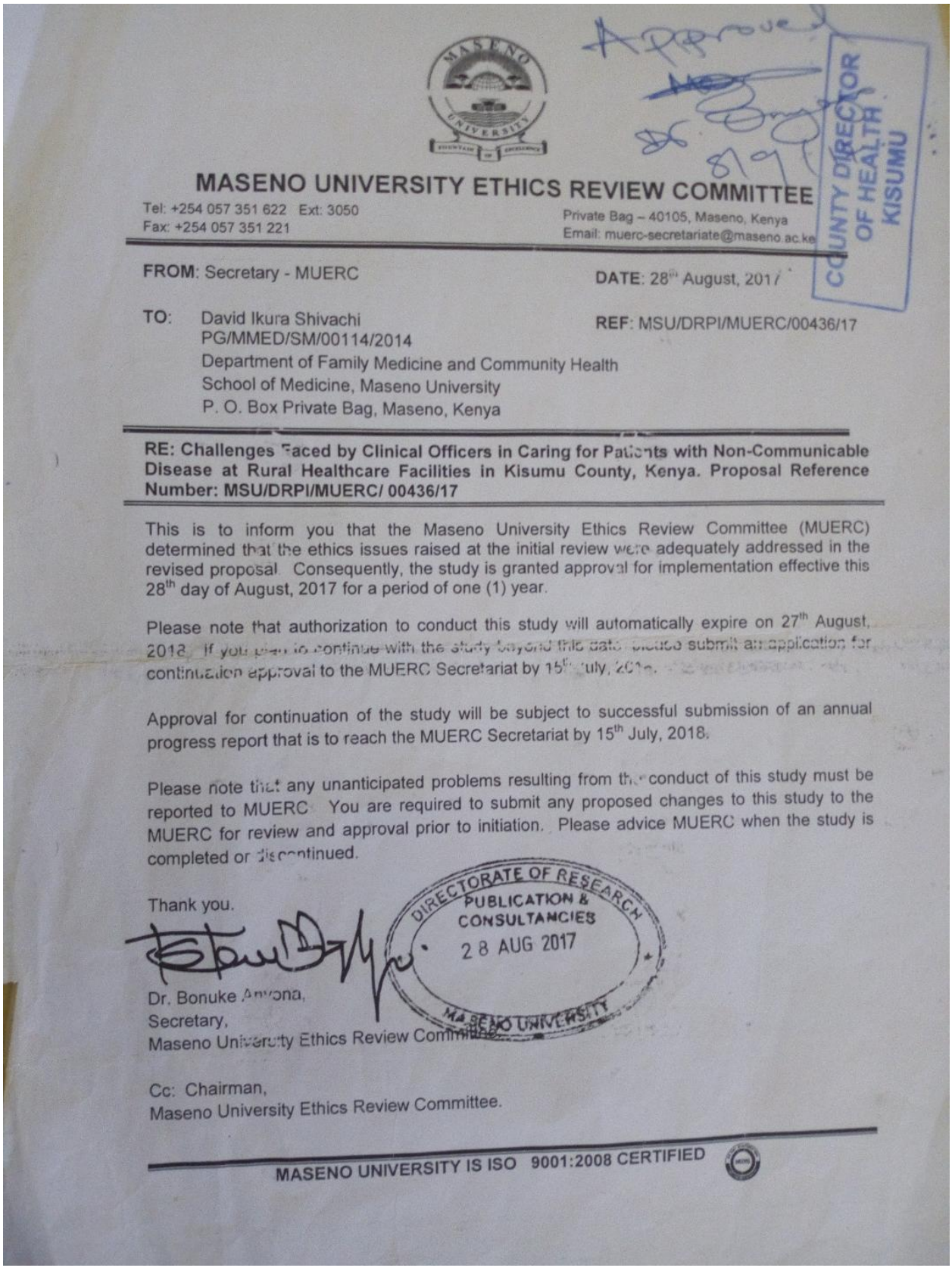
I have attached list of facilities to participate and a participant's consent form.

Your consideration is appreciated.

David Ikura Shivachi

CC. 1. COUNTY CLINICAL OFFICER

Appendix 14 Kisumu county director of health approval



MASENO UNIVERSITY ETHICS REVIEW COMMITTEE

Tel: +254 057 351 622 Ext: 3050
Fax: +254 057 351 221

Private Bag – 40105, Maseno, Kenya
Email: muerc-secretariate@maseno.ac.ke

Approved

COUNTY DIRECTOR OF HEALTH KISUMU

FROM: Secretary - MUERC

DATE: 28th August, 2017

TO: David Ikura Shivachi
PG/MMED/SM/00114/2014
Department of Family Medicine and Community Health
School of Medicine, Maseno University
P. O. Box Private Bag, Maseno, Kenya

REF: MSU/DRPI/MUERC/00436/17

RE: Challenges Faced by Clinical Officers in Caring for Patients with Non-Communicable Disease at Rural Healthcare Facilities in Kisumu County, Kenya. Proposal Reference Number: MSU/DRPI/MUERC/ 00436/17

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DIRECTORATE OF RESEARCH PUBLICATION & CONSULTANCIES 28 AUG 2017 MASENO UNIVERSITY

Thank you.

Dr. Bonuke Anyona,
Secretary,
Maseno University Ethics Review Committee

Cc: Chairman,
Maseno University Ethics Review Committee.

MASENO UNIVERSITY IS ISO 9001:2008 CERTIFIED