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COLLEGE OF HEALTH SCIENCES

SCHOOL OF PUBLIC HEALTH

Prevalence and factors associated with chronic kidney disease among medical inpatients at the Kenyatta National Hospital, 2018

Valerian Mwenda

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Declaration

Declaration by the Candidate

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Signature_____Date_____

Dr Valerian Mwenda

Declaration by Supervisors

This thesis has been submitted for examination with our approval as University Supervisors.

1. Professor Willis Owino-Ong'or

Affiliation: School of public health, college of Health Sciences, Moi University

Signature_____ Date_____

2. Dr Gladwell Gathecha

Affiliation: Department of Non-Communicable Diseases, Ministry of Health, Kenya

Signature_____ Date _____

Dedication

This work is dedicated to Ireen Mwenda; a friend, confidant and companion.

Abstract

The burden of chronic kidney disease (CKD) is increasing worldwide. Population surveys are the gold-standard for CKD burden determination; these are time and financial resource-intensive. Prevalence of CKD among medical inpatients in tertiary facilities has been used to estimate disease burden in resource-constrained settings. We aimed to describe prevalence and factors associated with CKD among medical inpatients at the largest referral hospital in Kenya. A cross-sectional study was conducted among medical inpatients at the Kenyatta National Hospital. Systematic sampling was used and data on demographic information, behavioural risk factors, medical history, underlying conditions, laboratory and imaging workup was collected using a structured questionnaire. Glomerular filtration rate (GFR) was estimated in ml/min/1.73m^2 using serum creatinine levels and classified into 5 stages; G1 (≥90), G2 (60-89), G3a (45-59), G3b (30-44), G4 915-29) and G5 (<15, or treated by dialysis/renal transplant). Ethical approval was obtained from the Moi University Institutional Research and Ethics Committee (FAN: IREC 2088) and Kenyatta National Hospital/University of Nairobi ethics committee (P510/09/2017). Prevalence of CKD was estimated and logistic regression applied to identify factors independently associated with CKD diagnosis.

A total of 306 inpatients were included; median age 40.0 years (IQR 24.0), 162 (52.9%) were male, 155 (50.7%) rural residents. Chronic Kidney Disease prevalence was 118 patients (38.6%, 95% CI 33.3-44.1); median age 42.5 years (IQR 28.0), 74 (62.7%) were male, 64 (54.2%) rural residents. Respondents with CKD were older than those without (difference 4.4 years, 95% CI 3.7-8.4 years, P=0.032). Fifty-six (47.4%) of the patients had stage G1 or G2, 17 (14.4%) had end-stage renal disease; 73 (61.9%) had haemoglobin <10g/dl while 33 (28.0%) had serum sodium levels below 135mmol/l. Male sex (aOR 2.63, 95% CI 1.49-4.63), prior history of anaemia (aOR 1.80, 95% CI 1.02-3.19), proteinuria (aOR 5.16, 95% CI 2.09-12.74), hematuria (aOR 7.68, 95% CI 2.37-24.86), history of hypertension (aOR 2.71, 95% CI 1.53-4.80) and herbal medications use (aOR 1.97, 95% CI 1.07-3.64) were independently associated with CKD.

In conclusion, the burden of CKD was high among this inpatient population. Male sex and prior history of anaemia, hypertension, herbal medications use, proteinuria or hematuria were the associated factors. We recommend that dipstick urinalysis should form part of screening packages in primary care settings and detection of blood or proteins serve as referral criteria for further CKD diagnostic work-up. We also recommend creation of public awareness on health hazards of herbal medication use.

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Acknowledgements

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List of abbreviations

AKI: Acute kidney Injury

aOR: Adjusted odds ratio

ARF: Acute Renal Failure

CDC: Centers for Disease Control and Prevention

CI: Confidence interval

CKD: Chronic Kidney Disease

CVD: cardiovascular disease

ESRD: End stage renal disease

FELTP: Field Epidemiology and Laboratory Training Programme

GFR: Glomerular filtration rate

IREC: Institutional Research and Ethics Committee

KNH: Kenyatta National Hospital

$MH_{OR:}$ Maentel Haenszel odds ratio

MOH: Ministry of Health

OR: Odds ratio

T2DM: Type 2 diabetes mellitus

UON: University of Nairobi

UTI: urinary tract infection

Definition of terms

Acute kidney injury: derangements in kidney function that lasts less than three months

Chronic kidney disease: Derangements in kidney function that lasts more than three months or is accompanied by structural damage in the organ.

End-stage renal disease: the severest form of chronic kidney disease, which requires renal replacement therapy, either through dialysis or transplantation.

Glomerular Filtration Rate: A measure of the functioning level of the kidneys.

Maentel Haenszel odds ratio: an average measure of association in different strata, used in stratified analysis for comparison with crude odds ratios.

Albuminuria: loss of the protein albumin in urine.

Proteinuria: presence of proteins in urine.

Haematuria: presence of blood, whether frank or microscopic, in urine.

Screening: Application of a simple test to identify a health condition in its early stages in a healthy population (with no symptoms).

CHAPTER ONE

1.0 Introduction

1.1 Background

Renal disease entails any condition that interferes with the kidney function either at the stage of blood flow to the organs, process of filtration and reabsorption of solutes or discharge of urine to the renal pelvis, ureters and eventually to the bladder (Hudson & Sinert, 2011; Kalima *et al.*, 2015). It is classified as acute or chronic, though these two entities are currently thought to be interconnected, with each predisposing an individual to the development of the other, the two acting in a continuum, or representing the advanced stages of each other (Chawla *et al.*, 2014). Acute kidney injury, formerly acute renal failure, is defined as increase in serum creatinine above one and half times the baseline or more than 0.3mg/dl (26.5µmoles/l) and urinary output less than 0.5ml/kg/h in the preceding six hours; the two criteria must be met before the diagnosis is made (Fliser *et al.*, 2012). Chronic kidney disease, defined as decreased kidney function shown by glomerular filtration rate (GFR) of less than 60 mL/min per 1·73 m(2), or markers of kidney damage, or both, of at least 3 months duration, regardless of the underlying cause (Webster *et al.*, 2017), is classified into five stages, with the severest form being end-stage renal disease which requires renal replacement therapy either in the form of dialysis or renal transplantation (Evans & Taal, 2011). The global burden of chronic kidney disease is estimated to be 11 to 13 % (Hill *et al.*, 2016) while the incidence of acute kidney injury in adults globally is around 22%, with a mortality of 24% (Susantitaphong *et al.*, 2013). The most prevalent risk factors for AKI include infectious diseases like malaria, HIV, bacterial sepsis and infectious diarrhoea (Li *et al.*, 2013) while chronic kidney disease primarily occurs as a complication of diabetes mellitus and hypertension (Ghaderian & Beladi-Mousavi, 2014). Rising prevalence of obesity and sedentary lifestyles is also linked to rising burden of CKD. The prevalence of these conditions is thought to be higher and rapidly rising in the low and

middle income countries, where poverty and inadequate access to healthcare are the key driving factors of the epidemics, with worsening of the fragile socio-economic balances in these same regions as a result of the disease burden (Nugent *et al.,* 2011). The economic burden of renal disease is immense, both at the individual and household level as well as on healthcare provision systems due to costs of specialized treatment and continued care. Laboratory investigations, management of complications, medications cost and lost productivity from occupational activities form the bulk of these costs (Wang *et al.*, 2016).

Though the exact prevalence of renal disease in Africa is not known, estimates point to a substantial burden especially in the middle-aged, in the background of inadequate treatment facilities and nephrologists (Naicker, 2010). The age standardized mortality from the disease rose substantially between 1990 and 2010, with the concurrent increase of other non-communicable diseases including diabetes, hypertension and cardiovascular disease (Lozano *et al.,* 2013). Though the estimates of the economic impact of kidney disease in Sub-Saharan Africa is not known, reports both from other parts of the world and specific treatment modalities like dialysis in low and middle income countries have shown a major contribution to total healthcare costs, both direct (goods or services expended in intervention provision as well as managing the complications of the disease) and indirect or productivity losses (Honeycutt *et al.*, 2013; Karopadi *et al.*, 2013; Mushi *et al.*, 2015).

Prevalence of the main risk factors for CKD in Kenya was high according to the STEPwise survey on non-communicable disease risk factors done in 2015, especially hypertension, inadequate physical activity and obesity (MoH-Kenya, 2015). This implies possible high prevalence of CKD in the general population. Though CKD prevalence in specific health conditions have previously been determined in Kenya, including in HIV (Ambetsa, 2014; Kairu, 2015), rheumatoid arthritis (Said, 2015), heart failure (Mwololo, 2013) and type 2 diabetes (Nyamai, 2014), the overall burden of chronic kidney disease and its various stages has not been

determined. Determination of CKD disease burden in a population is pivotal for public health planning and guiding implementation, monitoring and evaluation frameworks for preventive efforts. Knowledge of overall prevalence of CKD and its various stages is important for several reasons. Early stages of renal diseases are amenable to treatment and follow-up to prevent or slow progression to more severe stages. Second, the severest form, which is end-stage disease constitutes the biggest consumer of health services and biggest contributor to morbidity and mortality from chronic kidney disease, especially due to electrolyte and haematological complications (Wang *et al.*, 2016) and is therefore important to policymakers and health sector planners. Knowledge on associated factors and underlying conditions would be valuable to preventive public health measures, since most kidney disease cases can be avoided or reversed by prompt management of underlying conditions. Since most of these factors are similar to other non-communicable disease especially cardiovascular ones (Subbiah *et al.*, 2016), it offers an opportunity for programmatic collaboration in their control. Determination of prevalence of complications and conditions associated with progression of CKD is important for guiding clinical management and follow-up.

The gold standard for CKD burden determination is population surveys; however this is made difficult due to time and financial constraints in many low and middle income countries. Determination of CKD burden among patients admitted in general medical wards in tertiary health facilities has been suggested as a proxy for disease burden in settings where population surveys are not feasible.

1.2 Problem statement

Kenyatta National Hospital, the largest referral health facility in Kenya handles approximately 60-80 cases of advanced CKD daily. Management of advanced CKD is cost-intensive, requires specialized personnel and infrastructure and has higher morbidity and mortality outcomes. Early CKD stages are asymptomatic; therefore people may not be aware they have the disease.

Yet, detection of these early stages can halt or slow down progression. Determination of burden of disease in a given population is pivotal for justification of resource allocation in public health interventions, especially in the era of dwindling budgetary allocations to healthcare and increasing disease burden (Arora *et al.*, 2015). In addition, Kenya has inadequate trained personnel and facilities for specialized kidney treatment (Bello *et al.*, 2017). There are no CKD surveillance systems in Kenya, population-based surveys and no screening packages for primary healthcare settings. Without epidemiological knowledge to guide public health response, the burden of CKD, especially the advanced stages will continue to rise in Kenya and will enormously strain the healthcare system.

1.3 Justification

No population survey on CKD has been done in Kenya. The only available CKD burden information is in patients with specific medical conditions including HIV, hypertension, type 2 diabetes and rheumatologic conditions. Kenyatta National Hospital handles referrals from the entire Kenyan population. The facility performs urinalysis, full haemogram and full electrolytes panel as a routine admission package. However, the results of these tests are rarely analyzed to determine presence or absence of CKD, unless in patients already know to have the condition. Determination of the CKD status among these patients admitted for different reasons can serve as a proxy for the prevalence of CKD and also guide monitoring and prevention of progression. The output from the current study will also inform the Ministry of Health as well as County Departments of Health as they plan investments in provision of affordable and accessible kidney disease treatments including renal replacement therapy to ESRD patients.

The findings of this study are meant to be utilized in two settings; public health and clinical management. Public health authorities can utilize the findings in planning and evaluating programmes targeting the underlying conditions of kidney disease and integration of CKD

screening in public health surveillance. The findings can also guide evaluation, management and follow-up for CKD patients in the healthcare system.

1.4 Research question

What is the prevalence and factors associated with chronic kidney disease among medical inpatients at the Kenyatta National Hospital?

1.5 Objectives

1.5.1 Main

To describe the prevalence and factors associated with chronic kidney disease among medical inpatients at the Kenyatta National Hospital.

1.5.2 Specific

1. To estimate the prevalence of chronic kidney disease among medical inpatients at the Kenyatta National Hospital (KNH).
2. To determine the prevalence of hematologic abnormalities among medical in-patients with chronic kidney disease at the KNH.
3. To determine the prevalence of electrolyte abnormalities among medical in-patients with chronic kidney disease at the KNH.
4. To describe socio-demographic and clinical factors associated with chronic kidney disease among medical inpatients at the KNH.

CHAPTER TWO

2.0 Literature review

2.1 Definition of kidney disease

Kidney disease is defined as the failure of the kidneys to perform their hemofiltration function, resulting in accumulation of various solutes, fluid overload and blood gases abnormalities (Germino & Guay-Woodford, 2014). Its increasing prevalence, burden and public health importance is associated with corresponding increase in both risk factors for and actual prevalence of the main underlying conditions including diabetes and hypertension, as well as obesity and increasing life expectancy worldwide (Salvador *et al.*, 2015). Though, conventionally divided into acute kidney injury and chronic kidney disease, the interconnection between the two conditions has been confirmed, with acute kidney injury progressing to chronic kidney disease in most instances and chronic kidney complicating as acute-on chronic renal failure as it advances on to end-stage disease (Chawla *et al.*, 2014; Leung *et al.*, 2013). However, the chronic kidney disease is used when there is evidence of persisting renal function abnormalities for more than three months.

2.2 The global burden of kidney disease

The current burden of kidney disease worldwide is estimated to be 10-20% for acute kidney injury and 10% for CKD, with a lifetime risk of 50% among adults (Levey, Becker, & Inker, 2015. Chronic kidney disease of various stages is increasing worldwide due to primarily the increase in the main predisposing factors in the community including diabetes, hypertension and increasing proportion of older individuals as life expectancy improve globally (Hill *et al.*, 2016). This has significantly caused an increase in both morbidity and mortality, primarily contributed by adverse cardiovascular outcomes, with oxidative stress identified as the most likely underlying pathogenic mechanism (Gosmanova & Le, 2011). There is marked

differences in both the prevalence of chronic kidney disease and end-stage renal failure in high and low income countries, with 80% burden reported in the former; however this may be due to under-reporting and patients not being accepted into renal replacement therapy programmes in the low income countries (Jha *et al.*, 2013).

Acute kidney injury (AKI), which is a major contributor to the mortality and morbidity caused by kidney disease globally is also increasing globally, with resultant need for renal replacement therapy; mortality from AKI is inversely associated with percentage Gross Domestic Product allocated to health and per-capita incomes (Susantitaphong *et al.*, 2013). Most cases of AKI also progress to CKD, therefore contributing to ongoing demand on kidney disease treatment facilities and personnel (Chawla *et al.*, 2014). There is a major challenge in estimating the true prevalence of chronic kidney disease globally since the bulk of cases in the earlier stages are asymptomatic, or have very non-specific symptoms hence delaying diagnosis and increasing the risk of progression to end-stage disease (Evans & Taal, 2011).

2.3 Economic impact of CKD globally

With overall prevalence of above 10% and in high-risk sub-populations exceeding 50%, CKD has placed an immense economic burden on health systems, due to increasing demand on specialized facilities and highly-trained personnel including physicians, nephrologists and renal nurses (Eckardt *et al.*, 2013). The costs increase exponentially as the severity of CKD increases, with the biggest proportion of the economic impact arising from the patients with stage three and above (Honeycutt *et al.*, 2013). Treatment approaches of end-stage renal disease are cost-effective in some countries due to availability of facilities and personnel (Karopadi *et al.*, 2013), but the continuum of care that most kidney patients require throughout their lives implies that overall costs remain substantial. This has resulted in a majority of patients in need of kidney treatment facilities in low and middle income economies worldwide not accessing these life-saving care (Liyanage *et al.*, 2015). To tackle this problem, surveillance for early CKD as well

as risk factors has been suggested and implemented in some countries, especially through community-based screening, but this has been implemented mainly in high-income countries only (Radhakrishnan *et al.*, 2014). Other factors noted to influence cost of care for CKD patients include presence of comorbidities, geographical location even within countries and possession and type of health care insurance (Damien *et al.*, 2016).

2.4 Prevalence of CKD in Africa

Though country-specific figures on prevalence and incidence of CKD in Africa are not available, estimates point to an increasing burden, accompanied by a severe shortage of specialized care facilities, especially dialysis and kidney transplant (Naicker, 2013). The disease is more prevalent in younger individuals, especially in rural areas, due to acute kidney injury contributed to by diarrhoea and other infectious diseases (Li *et al.*, 2013). The cost of dialysis, for instance, has been noted to be over-proportional in poorer countries and beyond the capability of individuals to pay for, even though most of the studies in these settings had several methodological challenges in cost estimations (Mushi *et al.*, 2015). In Kenya, though studies on prevalence of kidney disease in specific conditions are available (Edwards *et al.*, 2015; Opiyo *et al.*, 2015), no studies have tried to determine the prevalence of end-stage renal disease among chronic kidney disease patients.

2.5 Risk factors for CKD

Several factors have been noted to be important in development of kidney disease and hence are avenues of public health intervention through preventive efforts (Kazancioğlu, 2013). These include the following:

(a) Genetics

Mutations of the angiotensin II type 1 receptors, angiotensinogen, angiotensin 1 converting enzyme, uromodulin and APOLI mutations have been associated with CKD, hence giving it a hereditary component (Köttgen *et al.*, 2009; Pollak *et al.*, 2012; Su *et al.*, 2012)

(b) Family history

Close family members (first degree relatives) of CKD patient have been found to be at a higher risk of developing the condition (Song *et al.*, 2009).

(c) Gender

Male gender has been associated with development of CKD in several studies, and the same applies for end-stage renal disease (ESRD) (Iseki, 2005; Takamatsu *et al.*, 2009)

(d) Ethnicity

Risk of developing CKD is higher among blacks compared with Caucasians (Lackland *et al.*, 2001; McClellan & Flanders, 2003; Nzerue *et al.*, 2002).

(e) Age

Renal function decreases with age in both men and women, hence the elderly are at a higher risk of developing CKD after various renal insults (Falodia & Singla, 2012; Iseki, 2005)

(f) Low birth weight

Intrauterine growth restriction results in lower nephron numbers in the newborns and subsequent intraglomerular hypertension, hyperfiltration in the available nephrons and lower overall GFR (Luyckx & Brenner, 2010; Vikse *et al.*, 2008)

(g) Obesity

This has been found to be the strongest, modifiable risk factor for ESRD, and especially central obesity (Chang & Kramer, 2012; Ejerblad *et al.*, 2006; Kwakernaak *et al.*, 2013). The proposed mechanisms include inflammation, oxidative stress, endothelial dysfunction, prothrombotic states, hypervolemia and adipokine derangements (Mirrakhimov, 2012)

(h) Socio-economic status

Less income, unskilled labour workers and less educated people have been found to be at a higher risk of developing CKD (Krop *et al.*, 1999; Plantinga, 2013)

(i) Smoking

Smoking increases the risk of developing CKD in a dose-response fashion (Bleyer *et al.*, 2000; Orth *et al.*, 2005), with the proposed mechanisms being inflammation, oxidative stress, endothelial dysfunction, glomerulosclerosis and tubular atrophy (Mirrakhimov, 2012). Smoking is an important emerging risk factor for CKD especially in Africa where anti-tobacco regulations are still weak and erratically enforced (McLigeyo, 1998).

(j) Nephrotoxins

Alcohol, recreational drugs, heavy metals and other prescription and over the counter medications have been associated with developing CKD (Falodia & Singla, 2012; Perneger *et al.*, 1994)

(k) Acute kidney injury

Patients who develop acute kidney injury have been noted to have up to ten fold higher risk of subsequently developing CKD or ESRD (Goldstein & Devarajan, 2011). Since the burden of this condition has been previously noted to be high in a Kenyan referral hospital (Were &

Otieno, 1992), this could point to a possible high burden of CKD in the Kenyan general population.

(l) Diabetes mellitus

Diabetes is the leading cause of CKD in both low and high income countries globally (McClellan & Flanders, 2003). This occurs through hyperfiltration, glycosylation and reactive oxygen species. Half of diabetics will develop nephropathy and 10% will progressively lose the kidney function during their lifetimes (Erek *et al.*, 2007; Lea & Nicholas, 2002)

(m) Hypertension

Hypertension is also a common risk factor for both CKD and ESRD, accounting for nearly one third of ESRD cases in some studies (Erek *et al.*, 2007; Lea & Nicholas, 2002)

(n) Obstructive sleep apnea

This has been noted to have an independent effect on risk of CKD and its progression (Mirrakhimov, 2012)

(m) Heart rate

Higher resting-state heart rates, especially above 85 beats per minute, have a greater magnitude of decreasing glomerular filtration rate and higher odds of developing proteinuria (Inoue *et al.*, 2009).

(n) Periodontal disease

Gum infections by Gram negative organisms are also recognized as a risk factor for CKD (Pradeep *et al.*, 2012).

(o) HIV

Chronic kidney disease is a common complication of HIV infection as a result of HIV infection itself, other co-morbid diseases and infections and effect of HIV treatment. The most common involvement of the kidney by HIV infection is HIV-associated nephropathy (HIVAN) and HIV-immune complex disease (Naicker, 2015).

2.6 Diagnosis and staging of chronic kidney disease

Since kidney disease presents with very non-specific symptoms that mimic other conditions like heart failure, liver failure and hypoproteinemias, the mainstay of diagnosis is blood tests to determine the levels of creatinine and calculation of the Glomerular Filtration Rate (GFR) as well as other tests like blood urea levels and urinary albumin excretion (Stevens & Levin, 2013; Vanmassenhove *et al.*, 2013). Chronic kidney disease is diagnosed by a combination of GFR estimation and determination of duration of dysfunction (> 3 months) or presence of indicators of chronic renal damage including anemia of chronic disease, abnormalities on imaging and electrolyte abnormalities (calcium and phosphorous).

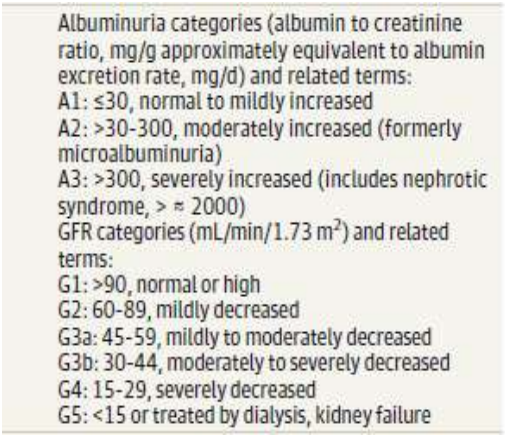

Albuminuria categories (albumin to creatinine ratio, mg/g approximately equivalent to albumin excretion rate, mg/d) and related terms:
A1: ≤30, normal to mildly increased
A2: >30-300, moderately increased (formerly microalbuminuria)
A3: >300, severely increased (includes nephrotic syndrome, > ≈ 2000)
GFR categories (mL/min/1.73 m^2) and related terms:
G1: >90, normal or high
G2: 60-89, mildly decreased
G3a: 45-59, mildly to moderately decreased
G3b: 30-44, moderately to severely decreased
G4: 15-29, severely decreased
G5: <15 or treated by dialysis, kidney failure

Figure 2: Staging of chronic kidney disease: (Levey *et al.*, 2015)

Stage G5 of CKD is the severest forms and usually requires renal replacement therapy, in form of dialysis or renal transplant.

2.7 Other diagnostic criteria for CKD

In addition to the determination of estimated glomerular filtration rate, other evaluations can also be undertaken to confirm a diagnosis of chronic kidney disease (Levey *et al.*, 2003). These markers of kidney damage include:

-Albuminuria of more than 30mg in 24 hours or urine albumin-creatinine ratio (UACR) of more than 30 mg/g.

-Urine sediment abnormalities

-Electrolyte abnormalities due to tubular dysfucntion.

-Renal abnormalities detected on histology after renal biospsy.

-Structural abnormalities detected by imaging

-History of kidney transplantation

2.8 Treatment and prevention

There are different forms of treatment for kidney disease depending with severity, with early stages treated conservatively with fluid balance restoration, diuresis and diet modification but severe forms requiring nephrologist referral and/or renal replacement therapy (Ferguson *et al.*, 2015). Advanced stages are associated with more cardiovascular morbidities, higher costs and mortality (Ortiz *et al.*, 2014). The best preventive strategies against kidney disease is early detection and prompt and proper management of the underlying conditions, as well as avoidance of risk factors (Johnson *et al.*, 2013).

2.9 Prevalence and factors associated with progression of early CKD to ESRD

ESRD is defined as the most severe form of CKD where there is minimal or no renal function, usually with GFR of below 15 ml/min/1.73m^2 and requiring renal replacement therapy in the form of either dialysis or renal trasnplant (Hudson & Sinert, 2011). It is the main cause of renal

morbidity and mortality among CKD patients and is also associated with high cost of health care (Honeycutt *et al.*, 2013). The prevalence of ESRD varies among various geographical regions, with 436 patients per a million popualtion (pmp) in Iran (Mousavi *et al.*, 2014), 660 patients pmp in Latin America (Gonzalez-Bedat *et al.*, 2015), and Taiwan reporting the highest prevalence globally at 2296 pmp (Lin *et al.*, 2014). Though there is paucity of reliable statistics on the prevalence of ESRD in Sub-Saharan Africa, estimates point to a high prevelence of the condition, with a bigger proportion affecting younger individuals comapred to other regions since CKD is more prevalent among 20-50 year olds in this region (Naicker, 2013).

Several factors have been associated with progression of kidney disease from stable CKD to ESRD in studies done outside Africa (McClellan & Flanders, 2003; Staples & Wong, 2010; Stringer *et al.*, 2013). These include the following:

- Hypertension
- Proteinuria
- Anemia
- Hyperuricemia
- Hyperlipidaemia
- Disorders of bone and mineral metabolism
- Smoking
- Low socio-economic status
- Lower education level
- Self report of cardiovascular disease
- Peripheral artery disease
- Serum phosphate levels
- Race
- Age
- Family history of ESRD

2.10 Role of health facility studies in CKD burden estimation

Prevalence of CKD in medical inpatients has been used in several studies in different countries and settings to estimate the overall disease burden and its complications. Though these health facility studies have various weaknesses, they are the only indicators of possible CKD disease burden in settings where population surveys have not been perfomed. These include Uganda (Kalima *et al.*, 2015), Botswana (Rwegerera *et al.*, 2017) and the United States (Ferris *et al.*, 2009). However, they require interpretation within the context of health facility studies.

2.11 Conceptual framework

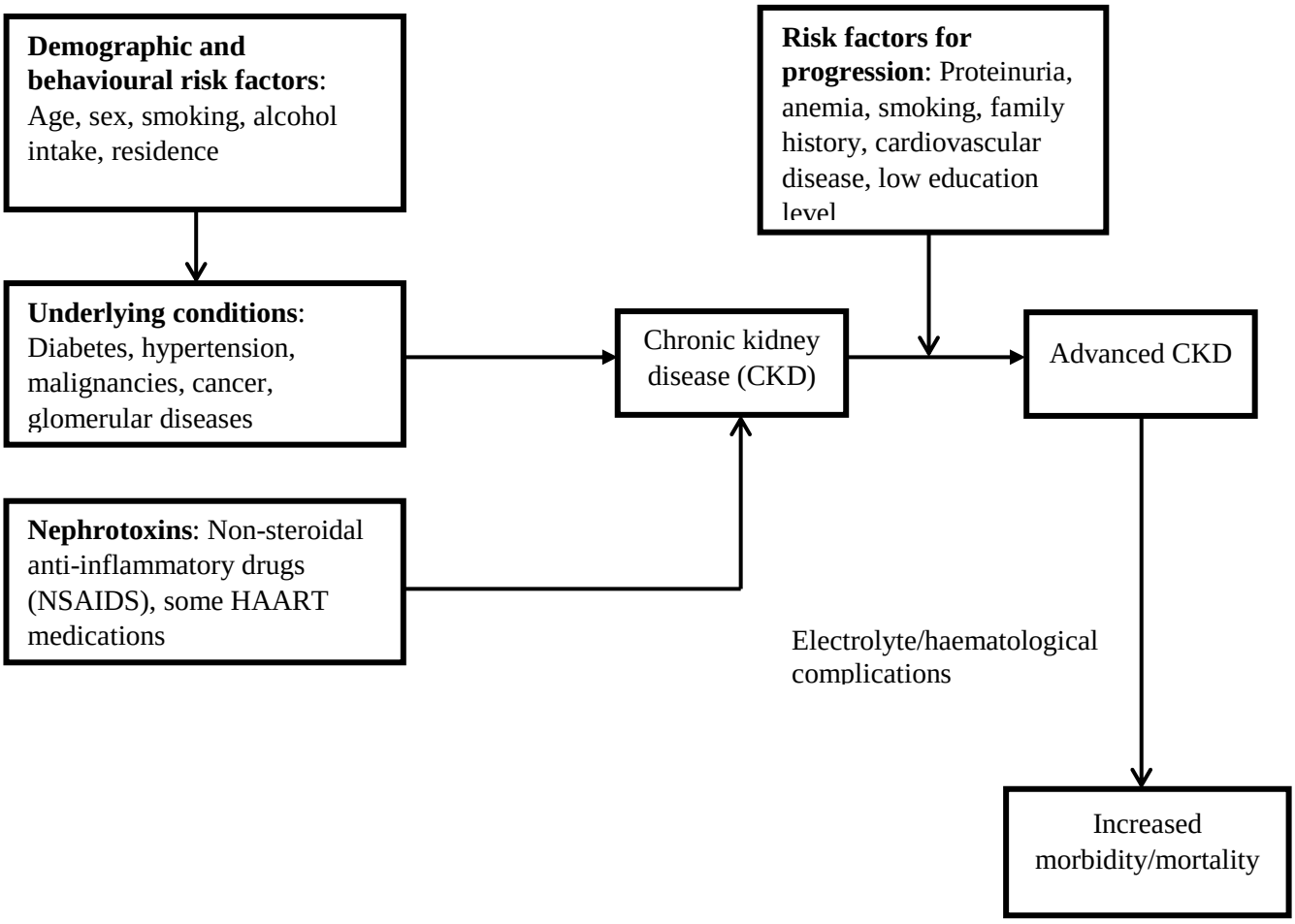


Figure 1: Conceptual framework

CHAPTER THREE

3.0 Methods

3.1 Study site

The study was conducted at the Kenyatta National Hospital in the medical wards. Kenyatta National Hospital is the biggest referral hospital in East and Central Africa, and is the main referral center for kidney disease in Kenya. Though KNH has an official bed capacity of 1410, the actual number of beds in current use is 1876, therefore carrying an extra one third of the recommended number of beds. Around 40% of the wards have more than 100% occupancy at any particular time. The hospital handles approximately 2000 inpatients and 1500 outpatients daily. It has eight medical wards, with an optimum inpatient capacity of 60-80 patients per ward at any particular time. The hospital has six renal specialists and has an outpatient renal unit that serves approximately 70 patients, with approximately 40 patients undergoing dialysis daily. The hospital attends to approximately 42000 patients monthly (information from hospital administration office and renal department). **Figure 3** shows the location of Nairobi County in Kenya and the location of KNH in Nairobi county; this puts the study site in context since KNH is a national referral facility that handles patients from the entire country.

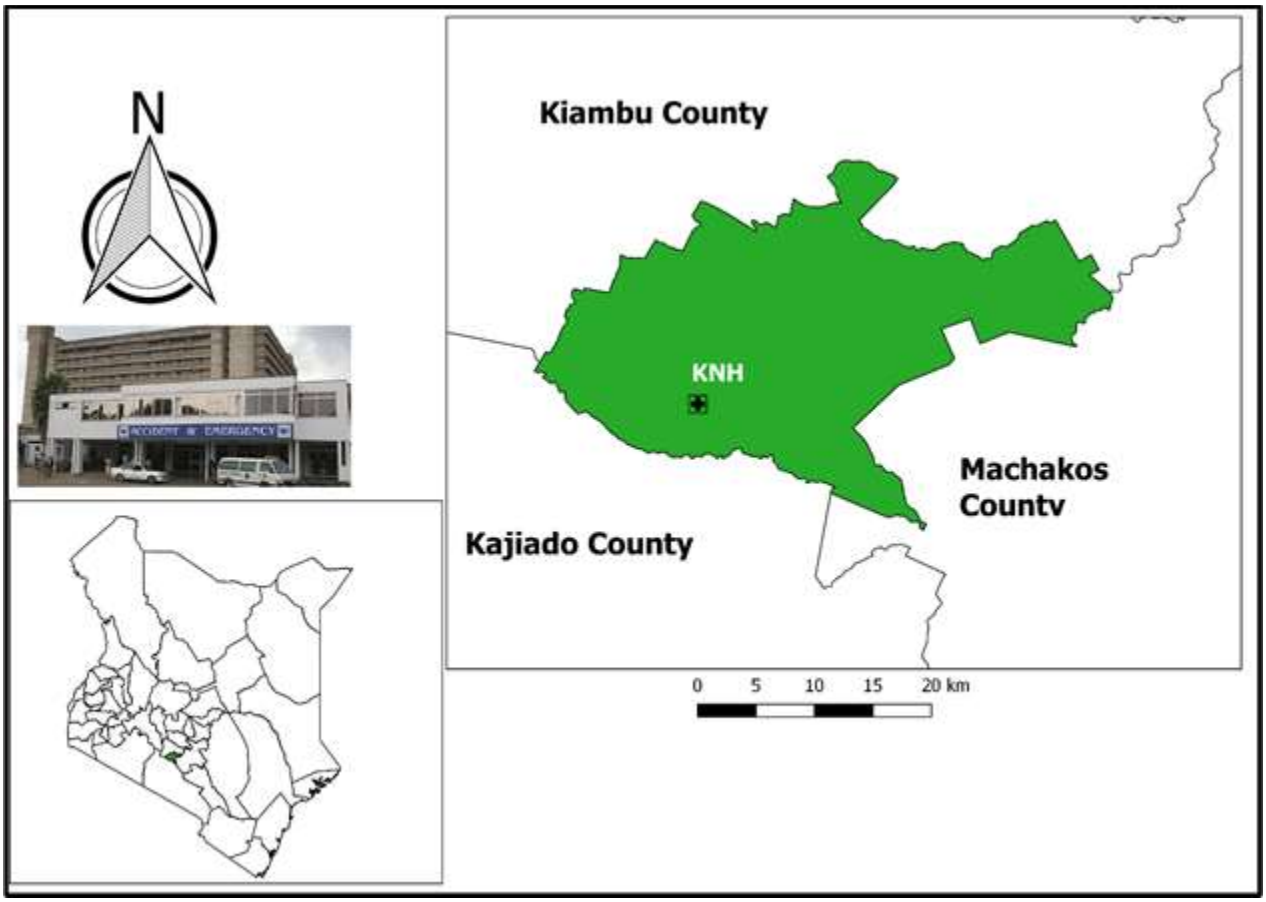


Figure 3: Map showing the study site

3.2 Study design

This was a cross-sectional study among adult patients admitted in the medical wards at the Kenyatta National Hospital.

3.3 Study population

The study population was all patients, above 18 years, admitted in the medical wards at the Kenyatta National Hospital, during the study period.

3.4 Sample size determination

The sample size was calculated using the Cochrane formula, recently expounded by Charan and Biswas, as shown below:

$$\text{Sample size (n)} = \frac{Z^2 P (1-P)}{d^2}$$ (Charan & Biswas, 2013)

Where n = sample size,

Z = Z statistic for a level of confidence, taken as 1.96 for 95% confidence interval

P = expected prevalence or proportion

d = precision (in proportion of one; if 5%, d = 0.05; usually preferred in many studies).

A previous study done in the United States (Ferris *et al.*, 2009) estimated the prevalence of chronic kidney disease in black medical inpatients at 27%. Using this figure, P=0.27, hence the computation of sample size was as follows:

$$\text{Sample size (n)} = \frac{1.96^2 \times 0.27 \times 0.73}{0.05^2} = 303$$

Therefore the sample size for the study was 303 participants.

3.5 Sampling procedures

Systematic sampling method was used in this study. Since the eight wards have the same inpatient capacity, the total sample size was divided equally among the wards. A pre-visit was conducted before the commencement of the study to ascertain the patients on admission per ward at the time of study. The sampling frame was the total number of patients admitted in a particular ward during the time of sampling. The sampling interval was determined as follows:

Number to be sampled from each ward=303/8≈38 patients

$$\text{Sampling interval (K)} = \frac{\text{No. of patients admitted in that particular ward at beginning of sampling}}{\text{Number to be sampled from each ward}}$$

Using the RAND function in Microsoft Excel 2013, we randomly selected a number between the first and the K^{th} patient as the first participant to be sampled and thereafter sampled every K^{th} patient. This was repeated till the required sample size from that ward was achieved; the procedure was then repeated in all the eight wards. Sampling with replacement was carried out by sampling the next sequential eligible inpatient in the event of a selected one opting out of the interview.

3.6 Inclusion criteria

All patients admitted in the medical wards, above the age of 18 years, who gave consent, were eligible for inclusion.

3.7 Exclusion criteria

The following patients were excluded from the study:

1. Patients with cognitive dysfunction.
2. Absence of requisite laboratory and/or imaging results. These include creatinine (for renal dysfunction determination), markers of CKD for those with abnormal creatinine (calcium, phosphate, proteinuria or typical findings on renal ultrasound), or CKD complications (full blood count).
3. Patients with extreme fatigue or weakness for data tool administration. This is especially for patients with marked fluid overload, dyspnea or voice impairment.

3.8 Data collection

Data was collected using structured questionnaires administered through face to face interviewing of the study participants. The questionnaire was pretested on 30 patients selected from the general medical outpatient clinic. Administration of the data collection tools was done at the setting of the medical wards by the principal investigator and three research assistants.

3.8.1 Socio-demographic variables and associated factors data

The following data was collected:

i. Socio-demographic variables: age, sex, employment status, residence (whether the participant lives in a town, city or not; as well as county of residence), marital status, education level,

ii. Associated factors: Primary diagnosis/ basis of admission, predisposing factors including behavioural risk factors of alcohol use (past and current) and cigarette smoking (past and current), history of HIV, cancer or diagnosed cardiovascular condition (deep venous thrombosis, peripheral vascular disease, heart failure, heart attack) prior to renal disease diagnosis or current admission, history of the following symptoms at a period before CKD diagnosis (for those already diagnosed) and this admission (no prior diagnosis): anaemia, proteins in urine (proteinuria), blood in urine (haematuria), kidney stones, recurrent urinary tract infections (two or more infections in six months), having a first degree relative with history of renal disease, use of non-steroidal anti-inflammatory medications daily for more than a month or any previous use of herbal medications.

3.8.2 Determination of chronic kidney disease prevalence and staging

Chronic kidney disease prevalence and staging was done from the serum creatinine levels. A full urea, electrolyte and creatinine panel is a mandatory baseline test for all patients admitted to the medical wards at KNH; this was utilized for the study. The Chronic Kidney Disease Epidemiology collaboration (CKD-Epi) equation for estimating glomerular filtration rate (eGFR) was used (Levey *et al.,* 2009). The equation is as follows:

$GFR = 141 \times \min(Scr/\kappa, 1)\alpha \times \max(Scr/\kappa, 1)\text{-}1.209 \times 0.993Age \times 1.018$ [if female] $\times 1.159$ [if black]

where:

- Scr is serum creatinine in mg/dL,
- κ is 0.7 for females and 0.9 for males,
- α is -0.329 for females and -0.411 for males,
- min indicates the minimum of Scr/κ or 1, and
- max indicates the maximum of Scr/κ or 1

3.8.3 CKD diagnosis

A diagnosis of CKD was defined as presence of decreased glomerular filtration rate (GFR) below 60 mL/min per 1.73 m2, or GFR above 60 mL/min per 1.73 m2 but with proteinuria, as determined by the Chronic Kidney Disease Epidemiology collaboration (CKD-Epi) equation, AND at least one of the following:

- Contracted kidneys, hypo-echoic kidneys or loss of corticomedullary differentiation on renal ultrasound (report from the hospital radiology department, by a radiologist)
- Serum phosphate levels above 1.4 mmol/l

- Serum calcium level below 2.2 mmol/l
- History of kidney transplantation
- History of documented kidney dysfunction for more than 3 months (from the interview or inpatient record)
- Anaemia of chronic disease (normochromic, normocytic, hypo-proliferative picture), with haemoglobin level of <10/dl.

After GFR estimation in ml/min/1.73m2 using serum creatinine levels, it was classified into 5 stages; G1 (≥90), G2 (60-89), G3a (45-59), G3b (30-44), G4 (15-29) and G5 (<15, or treated by dialysis/renal transplant). Chronic kidney disease prevalence was determined by determining the proportion of the study participants who met the case definition out of the entire sample size, as shown below:

Prevalence of CKD in the study= number meeting case definition/306

Prevalence of CKD complications=number of CKD cases with electrolyte and/or hematologic abnormalities/Total number of participants with CKD

The decision to use the investigations already performed on the medical inpatients was arrived after the following findings on study pre-visits at the accident and emergency (admission point), laboratory and imaging departments and three of the eight medical wards:

- All patients had full blood count, blood chemistry and urinalysis as routine investigations before admission to the wards. Ultrasonography was performed on selected patients either before or after admission.
- A cross-check of various patient records in the visited wards confirmed the availability of the tests results detailed above.

- The investigations were performed in the hospital (KNH) laboratories and imaging department, with the respective equipment having the following specifications:
    - The full blood count is performed by automated hematologic analyzer CD3200 and CD1300
    - Urea, creatinine, electrolytes and bone chemistry (calcium and phosphate) performed at the clinical chemistry/biochemistry laboratory using DIMI CS 4000 routine chemistry analyzer and Biolis 50i Superior routine chemistry analyzer.
    - Ultrasounds are performed using five machines: GE-Logic 7, GE-volution P9, GE-logic 5, GE-LOGIC Pro and Philips HD-11.
- Therefore we utilized these already performed investigations, to minimize repeat workups and unnecessary participant discomfort.

3.9 Data management

Data was loaded into Epi Info 7 statistical software, for cleaning, re-organization, coding and analysis. Continuous variables like age were expressed in median (interquartile range). Categorical variables like stage of kidney disease, sex, type of treatment were expressed in proportions, in the form n (%). Prevalence of CKD was calculated as the proportion of study participants who met the case definition out of the total number of participants. Proportion of participants with CKD and presence of one or more electrolyte or haematological abnormalities was also done. Using selected variables as independent factors and CKD diagnosis as the outcome factor, Chi-square test was used to test for associations at bivariate level. Factors associated with CKD with a p-value of less than 0.15 after bivariate analysis (Bursac *et al.*, 2008) were evaluated using logistic regression, employing the forward selection approach, and factors with P-value less than 0.05 (confidence interval around the odds ratio estimate excluding

the null, which is 1.0) were considered independently associated with CKD diagnosis. In exploratory analysis on the interaction between hypertension and type 2 diabetes (which are known to co-exist frequently), stratified analysis, calculation of Maentel-Haenszel Odds Ratio (MH_{OR}) as well as creation of an interaction term between type 2 diabetes and hypertension in the model were carried out. The two strata were association between type 2 diabetes and CKD in the presence and absence of hypertension. The following formula was used for calculation of the MH_{OR}:

Stratum 1

	CKD	No CKD	
Exposed (Type 2 diabetes + hypertension)	a_1	b_1	a_1+b_1
Unexposed (no type 2 diabetes + hypertension)	c_1	d_1	c_1+d_1
			$T_1=a_1+b_1+c_1+d_1$

Stratum 2

	CKD	No CKD	
Exposed (Type 2 diabetes)	a_2	b_2	a_2+b_2
Unexposed (no type 2 diabetes)	c_2	d_2	c_2+d_2
			$T_2=a_2+b_2+c_2+d_2$

$$\text{MH odds ratio} = \frac{(a_1 \times d_1/T_1) + (a_2 \times d_2/T_2)}{(b_1 \times c_1/T_1) + (b_2 \times c_2/T_2)}$$

Presence of effect modification was examined by comparing the crude OR, stratum specific OR and the $MH_{OR,}$ as well as the P-value of the interaction term in the model. Confounding was examined by computing the difference in the crude OR and the MH_{OR}, as well as observing how the variable performed in the final model.

3.10 Data dissemination

Findings from this research were disseminated as follows

i. To the Field Epidemiology Training Programme, Kenya, through a presentation and a report.
ii. Division of Non-communicable Diseases, Ministry of Health, through a presentation and a report.
iii. The Kenyatta National Hospital, renal and administration departments, through a summary report.
iv. To colleagues in the medical field through Continuous Medical Education presentations.
v. To the wider scientific community through a journal publication currently undergoing peer review.

3.11 Data quality control and quality assurance

Data quality checks were performed throughout data collection, cleaning and analysis. No missing data was found in the database created before analysis. The quality guidelines detailed below were followed to ensure quality of data collection and handling:

i. The study protocol was reviewed and approved by Moi University Institutional Review and Research Ethics Committee (IREC) and the Kenyatta/University of Nairobi Ethics and Research Committee (ERC).
ii. Probability sampling methods were used in the study.
iii. The data collection instrument/questionnaire was pilot-tested on 30 individuals at the medical outpatient clinic before commencement of the study. This was to check appropriateness and understanding of the questions on the tool.

iv. The medical records were scrutinized for adequacy of requisite information on laboratory records, and if found inadequate, was excluded.

3.12 Ethical Considerations and authority

Ethical approval was sought from the Institutional Research and Ethics Committee (IREC) of Moi University and University of Nairobi/Kenyatta National Hospital Ethics and Review Committee (ERC), under whose ethical jurisdiction the study took place. We also got permission for the study from the KNH administration. The recruitment process was as follows:

- The sampling criteria were applied as detailed earlier.
- The selected study participant's medical file was scrutinized for availability of the minimum requisite laboratory and/or imaging test results.
- If the participant met inclusion criteria, the consenting process was undertaken.
- If the participant consented, the questionnaire was administered.
- If the participant fell within the exclusion criteria or refused to grant consent, the next eligible participant as per the sampling procedures was consented (sampling with replacement).

The study was clearly explained to potential participants in a language they understand (English or Kiswahili) after which they were required to give written consent. All personal identifiers were removed and each patient assigned a study number. Strict confidentiality was maintained for all the data collected.

We made it clear to the patients that participation was voluntary, and they did not stand to lose anything if they declined to participate in the study. Further, no monetary gains were promised to participating patients. No harms were foreseen or expected for the participants of this study, other than slight discomfort during administration of the study tool.

No direct benefits to the participants were expected in this study, but they were informed that it will contribute to generalizable knowledge that can assist public health authorities to put in place policies and strategies to reduce burden of chronic kidney disease.

CHAPTER FOUR

4.0 Results

4.1 Socio-demographic characteristics

We interviewed a total of 306 patients, with a mean age of 40.0 years (IQR 24.0 years); 162 (52.9%) of these were male. Approximately half were rural residents. On level of education, 51.0% had at least completed secondary education, 11.4% had started but not completed secondary school, 18.0% had only completed primary school, 13.1% had started but not completed primary school while 6% had no formal education at all. Majority of the respondents (59.5%) were married, 21.6% were single and the rest separated, widowed or divorced. Most of the respondents (54.0%) were either in part-time or full-time employment, 28.1% were unemployed, 10.8% were homemakers and 7.2% were retirees **(Table 4.1)**

Table 4.1: Socio-demographic Characteristics of the Study Participants, Kenyatta National Hospital, Kenya, 2018 (n=306)

Variable	Categories	Frequency (%)
Sex	Female	144 (47.1)
	Male	162 (52.9)
Age (years)	Less than 40	141 (46.1)
	40 and above	165 (53.9)
Residence	Rural	155 (50.7)
	Urban	151 (49.3)
Education level	No formal education	19 (6.2)
	Primary incomplete	40 (13.1)
	Primary complete	55 (18.0)
	Secondary incomplete	35 (11.4)
	Secondary complete	91 (29.7)
	College and above	66 (21.6)
Marital status	Single	66 (21.6)
	Married	182 (59.5)
	Separated	20 (6.5)
	Divorced	9 (2.9)
	Widowed	29 (9.5)
Occupation	Unemployed	86 (28.1)
	Homemaker	33 (10.8)
	Part-time employment	96 (31.4)
	Fulltime employment	69 (22.6)
	Retired	22 (7.2)

4.2 Counties of origin for study participants

The study participants originated from 33 (70%) of the 47 Kenyan Counties. The majority (65.4%) came from outside Nairobi County **(Figure 4.1).**

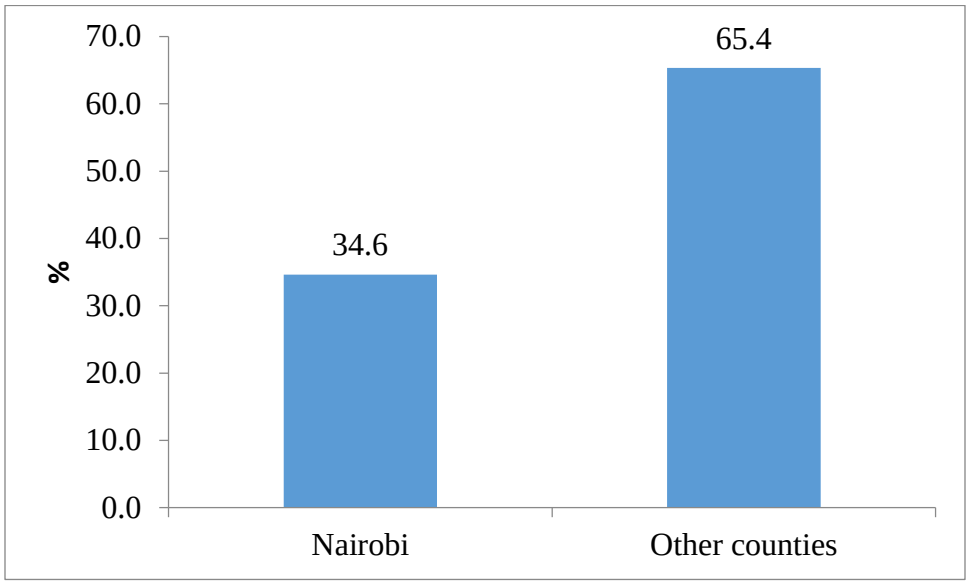


Figure 4.1: Counties of origin of the study participants, KNH 2018 (n=306)

4.3 Prevalence of CKD

A total of 118 medical inpatients from the sampled 306 met the case definition of CKD, translating to a prevalence of 38.6% (95% CI 33.3-44.1). The median age for the CKD patients was 42.5 years (IQR 28 years). Respondents with CKD were older than those without (age difference 4.4 years, 95% CI 3.7-8.4 years, P=0.032. Males formed the majority of the CKD patients at 63% while 54% were rural residents.

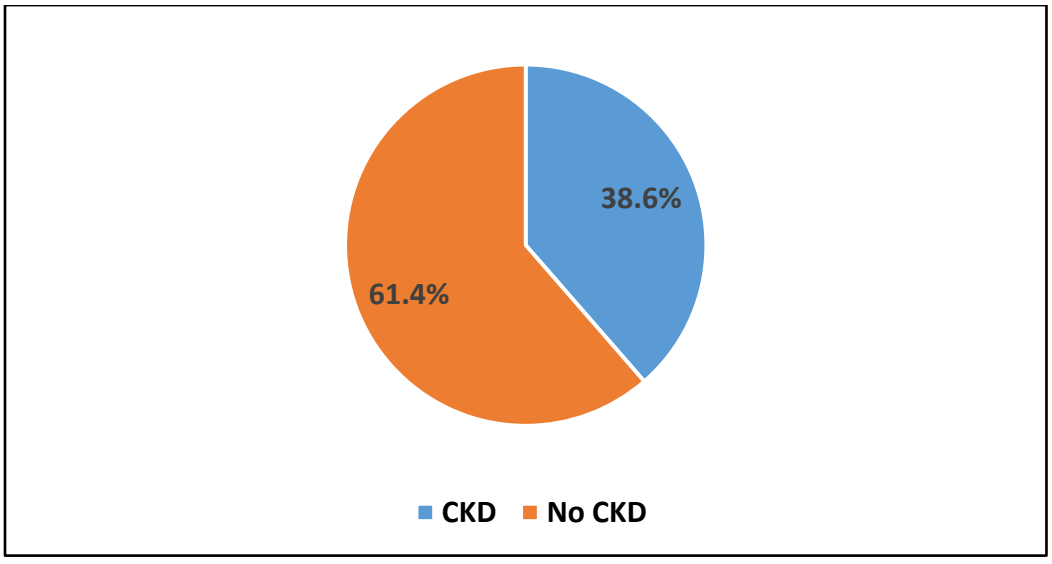


Figure 4.2: Prevalence of CKD in the study population, KNH 2018 (n=306).

4.3.1 Distribution of CKD cases by sex and residence

Majority of the CKD cases were male (62.7%) and rural residents (54.2%), as shown in **table 4.2.**

Table 4.2: Distribution of CKD cases by sex and residence, KNH 2018 (n=118)

Variable	Category	Frequency (%)
Sex	Female	44 (37.3)
	Male	74 (62.7)
Residence	Rural	64 (54.2)
	urban	54 (45.8)

CKD; chronic kidney disease

4.3.2 Chronic kidney disease cases by county of residence

Cases of CKD originated from 26 out of the 47 Kenyan Counties, spanning the coastal, central, rift valley and Western parts of the country. The Counties contributing the highest number of cases were Nairobi (28.0%) and Kiambu (15.3%). **(Figure 4.3)**

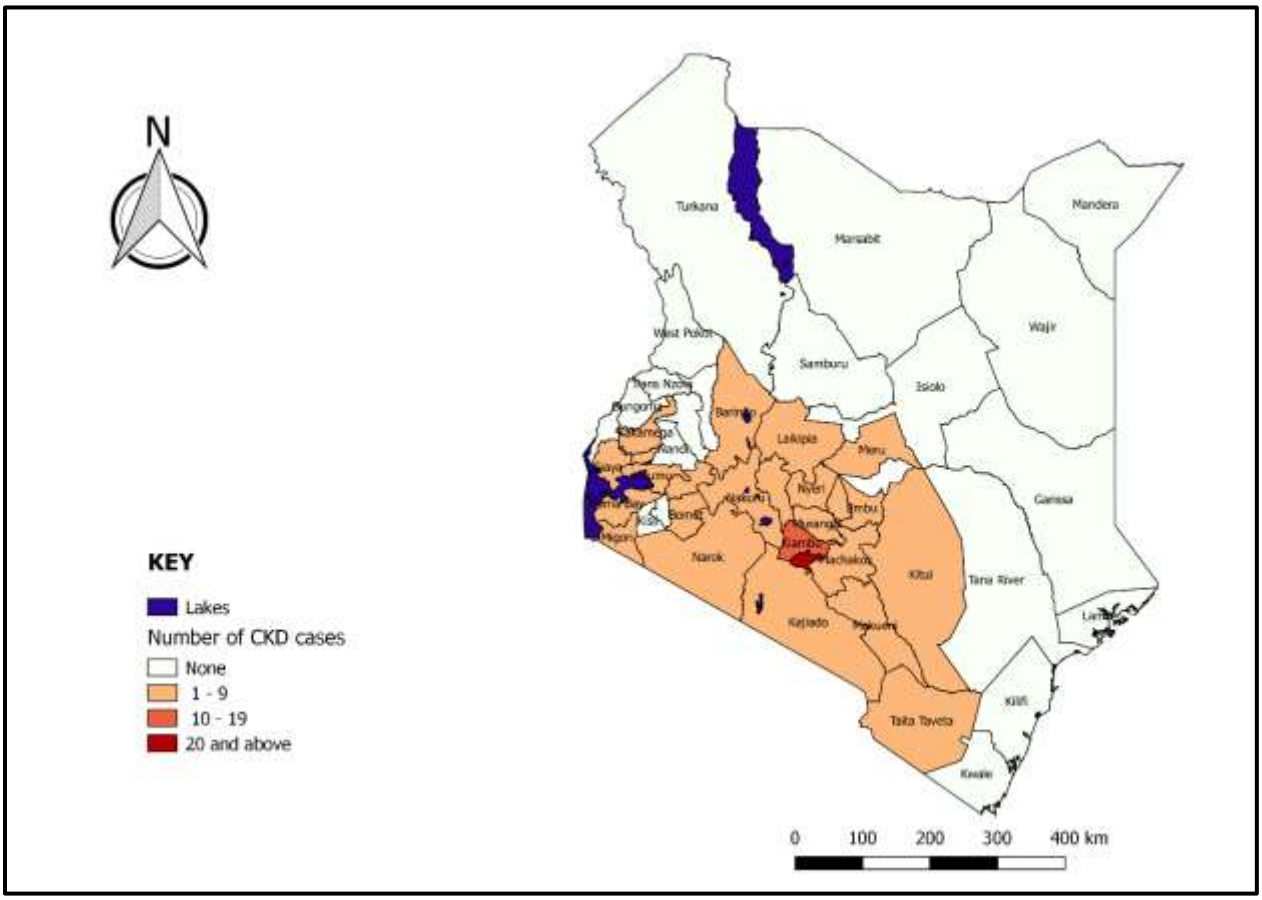


Figure 4.3: Chronic kidney disease cases by county of residence, KNH 2018

4.3.3 Chronic kidney disease stages by GFR

Classified by GFR stage, 47.5% of the CKD patients had mild disease (G1 and G2); while 14% were stage 5, also referred to as end-stage renal disease. Advanced CKD (stage 4 and 5) was present in 28.0% of the CKD patients; males formed the majority of those with advanced disease (64.3%). **(Table 4.3)**

Table 4.3: Chronic kidney disease staging staging by GFR, KNH 2018 (n=118)

GFR Stage (ml/min/1.73m^2)	Frequency	%
G1 (≥90)	20	16.9
G2 (60-89)	36	30.5
G3a (45-59)	23	19.5
G3b (30-44)	11	9.3
G4 (15-29)	11	9.3
G5 (<15)	17	14.4

GFR: Glomerular filtration rate

4.3.4 Chronic kidney disease diagnostic criteria

On the criteria used to assign respondents to CKD status in addition to elevated serum creatinine, majority (54%) had the abnormality for more than three months, 26% had normocytic normochromic anaemia (with haemoglobin level below 10g/dl), 14% had abnormal bone chemistry while 5% had suggestive features on ultrasound. **(Table 4.4)**

Table 4.4: Contribution of various criteria for CKD diagnosis, KNH 2018 (n=118)

Criteria	Frequency	%
History of renal dysfunction of >3 months	64	54.2
Normocytic normochromic anaemia (Hb<10g/dl)	31	26.3
Serum phosphate above 1.4mmol/l	11	9.3
Serum calcium below 2.2 mmol/l	6	5.1
Contracted kidneys, hypoechoic kidneys, loss of corticomedullary junction on ultrasound	6	5.1

Hb: haemoglobin, CKD: chronic kidney disease

4.3.5 Burden of haematological and electrolyte abnormalities among CKD patients

Among the CKD patients, 54% had anaemia and 28% had hyponatremia **(Table 4.5)**

Table 4.5: Prevalence of hematologic and electrolyte abnormalities among the CKD cases, KNH 2018 (n=118)

	Frequency (%)		
Derangement	**Overall (n=118)**	**Male (n=74)**	**Female (n=44)**
Anaemia Hb <10g/dl	73 (61.9)	43 (58.1)	30 (68.2)
Serum sodium below 135 mmol/l	33 (28.0)	21 (28.4)	12 (27.3)
Serum Potassium above 5 mmol/l	22 (18.6)	13 (17.6)	9 (20.5)
Serum phosphate >1.4 mmol/l	11 (9.3)	7 (9.5)	4 (9.1)
Serum calcium below 2.2 mmol/l	6 (5.1)	5 (6.8)	1 (2.3)

Hb: haemoglobin, CKD: chronic kidney disease

4.4 Bivariate analysis

Males had two times higher odds of CKD diagnosis than females (OR 1.91, 95% CI 1.19-3.06), tobacco users had two times higher odds of CKD diagnosis (OR 1.76, 95% CI 1.08-2.88), those taking alcohol had two times higher odds of CKD diagnosis (OR 2.10, 95% CI 1.32-3.36). Respondents with history of blood in urine had 13 times higher odds of CKD diagnosis (OR 13.0, 95% CI 4.29-52.35), those diagnosed with renal stones in the past had nine times higher odds (8.61, 95% CI 4.02-18.97); as were those with history of proteins in urine (OR 8.73, 95% CI 4.02-18.97). On previous diagnoses, respondents with previous diagnosis of CVD has 2 times higher odds (OR 1.76, 95% CI 1.09-2.86), T2DM 2 times higher odds (OR 1.95, 95% CI 1.11-3.45), recurrent urinary tract infections 2 times higher odds (OR 2.33, 95% CI 1.37-3.95) and hypertension 4 times higher odds (OR 3.57, 95% CI2.16-5.91) of CKD diagnosis compared with those without these conditions **(Table 4.6).**

Table 4.6: Factors associated with CKD status at bivariate level, KNH 2018 (n=118)

Variable	Response	Outcome			95% Confidence	
		CKD (n, %)	No CKD (n, %)	OR	interval	P value
Age ≥40 years	Yes	69 (58.5)	96 (51.1)	1.35	0.85-2.15	0.251
	No	49 (41.5)	92 (48.9)			
Sex	Male	74 (62.7)	88 (46.8)	1.91	1.19-3.06	0.009
	Female	44 (37.3)	100(53.2)			
Any chronic disease	Yes	99 (83.9)	134 (71.3)	2.10	1.17-3.76	0.017
	No	19 (16.1)	54 (28.7)			
Cancer	Yes	15 (12.7)	30 (16.0)	0.77	0.39-1.50	0.539
	No	103 (87.3)	158 (84.0)			
Circulation disorders	Yes	39 (33.1)	39 (20.7)	1.89	1.12-3.18	0.023
	No	79 (66.9)	149 (79.3)			
Type 2 diabetes	Yes	31 (26.3)	29 (15.4)	1.95	1.11-3.45	0.029
	No	87 (73.7)	159 (84.6)			
Hypertension	Yes	57 (48.3)	39 (20.7)	3.57	2.16-5.91	0.000
	No	61 (51.7)	149 (79.3)			
HIV	Yes	20 (17.0)	40 (21.3)	0.76	0.42-1.37	0.435
	No	98 (83.0)	148 (78.7)			
Nephrotoxic drug use	Yes	84 (71.2)	136 (72.3)	0.94	0.57-1.57	0.930
	No	34 (28.8)	52 (27.7)			
NSAIDS	Yes	70 (59.3)	110 (58.5)	1.03	0.65-1.65	0.983
	No	48 (40.7)	78 (41.5)			
Tobacco use	Yes	46 (39.0)	50 (26.6)	1.76	1.08-2.88	0.032
	No	72 (61.0)	138 (73.4)			
Relative with renal disease	Yes	17 (14.4)	14 (7.5)	2.09	0.99-4.42	0.077
	No	101 (85.6)	174 (92.5)			
Alcohol use	Yes	70 (59.3)	77 (41.0)	2.10	1.32-3.36	0.003
	No	48 (40.7)	111 (59.0)			
CVD	Yes	49 (41.5)	54 (28.7)	1.76	1.09-2.86	0.029
	No	69 (58.5)	134 (71.3)			
Residence	Urban	97 (51.6)	54 (45.8)	1.26	0.80-2.00	0.381
	Rural	91 (48.4)	64 (54.2)			
Recurrent UTI	Yes	41 (34.8)	35 (18.6)	2.33	1.37-3.95	0.002
	No	77 (65.2)	153 (81.4)			

(Continued)

Variable	Response	Outcome CKD (n, %)	Outcome No CKD (n, %)	OR	95% Confidence interval	P value
Hematuria history	Yes	26 (22.0)	4 (2.1)	13.0	4.29-52.35	0.000
	No	92 (78.0)	184 (97.9)			
Herbal medications use	Yes	34 (28.8)	37 (19.7)	1.65	0.97-2.83	0.089
	No	84 (71.2)	151 (80.3)			
History of proteinuria	Yes	36 (30.5)	9 (4.8)	8.73	4.02-18.97	0.000
	No	82 (69.5)	179 (95.2)			
History of Kidney stones	Yes	10 (8.5)	2 (1.1)	8.61	1.78-81.72	0.002
	No	108 (91.5)	186 (98.9)			
History of anemia	Yes	57 (48.3)	58 (30.9)	2.09	1.30-3.37	0.003
	No	61 (51.7)	130 (69.1)			

OR: odds ratio, CI; confidence interval, CKD: chronic kidney disease, CVD: cardiovascular disease, UTI: urinary tract infection, NSAIDS: non-steroidal anti-inflammatory drugs

4.5 Multivariable analysis

On multivariate analysis, male sex, previous history of haematuria, anaemia and proteinuria, hypertension and history of herbal medication use were independently associated with a diagnosis of CKD **(Table 4.7)**

Table 4.7: Factors independently associated with being a Chronic Kidney Disease case, Kenyatta National Hospital, Kenya, 2018 (n=306)

Variable	Response	CKD n (%)	No CKD n (%)	OR (95% CI)	aOR (95% CI)
Age ≥40 years	Yes	69 (58.5)	96 (51.1)	1.35 (0.85, 2.15)	
	No	49 (41.5)	92 (48.9)	Ref	
Sex	Male	74 (62.7)	88 (46.8)	1.91 (1.19, 3.06)	**2.63 (1.49, 4.63)**
	Female	44 (37.3)	100 (53.2)	Ref	
Any chronic disease	Yes	99 (83.9)	134 (71.3)	2.10 (1.17, 3.76)	1.28 (0.64, 2.57)
	No	19 (16.1)	54 (28.7)	Ref	
Cancer	Yes	15 (12.7)	30 (16.0)	0.77 (0.39, 1.50)	
	No	103 (87.3)	158 (84.0)	Ref	
Type 2 diabetes	Yes	31 (26.3)	29 (15.4)	1.95 (1.11, 3.45)	1.29 (0.66-2.52)
	No	87 (73.7)	159 (84.6)	Ref	
Hypertension	Yes	57 (48.3)	39 (20.7)	3.57 (2.16, 5.91)	**2.71 (1.53, 4.80)**
	No	61 (51.7)	149 (79.3)	Ref	
HIV infection	Yes	20 (17.0)	40 (21.3)	0.76 (0.42, 1.37)	
	No	98 (83.0)	148 (78.7)	Ref	
Nephrotoxic drug use	Yes	84 (71.2)	136 (72.3)	0.94 (0.57, 1.57)	
	No	34 (28.8)	52 (27.7)	Ref	
NSAIDS	Yes	70 (59.3)	110 (58.5)	1.03 (0.65, 1.65)	
	No	48 (40.7)	78 (41.5)	Ref	
Tobacco use	Yes	46 (39.0)	50 (26.6)	1.76 (1.08, 2.88)	0.89 (0.47, 1.69)
	No	72 (61.0)	138 (73.4)	Ref	
Relative with renal disease	Yes	17 (14.4)	14 (7.5)	2.09 (0.99, 4.42)	0.90 (0.33-2.46)
	No	101 (85.6)	174 (92.5)	Ref	
Alcohol use	Yes	70 (59.3)	77 (41.0)	2.10 (1.32, 3.36)	1.37 (0.81, 2.31)
	No	48 (40.7)	111 (59.0)	Ref	
Cardiovascular disease	Yes	49 (41.5)	54 (28.7)	1.76 (1.09, 2.86)	1.41 (0.76-2.63)
	No	69 (58.5)	134 (71.3)	Ref	
Residence	Urban	97 (51.6)	54 (45.8)	1.26 (0.80, 2.00)	
	Rural	91 (48.4)	64 (54.2)	Ref	
Recurrent UTI	Yes	41 (34.8)	35 (18.6)	2.33 (1.37, 3.95)	1.23 (0.65, 2.32)
	No	77 (65.2)	153 (81.4)	Ref	
Hematuria history	Yes	26 (22.0)	4 (2.1)	13.00 (4.29, 52.35)	**7.68 (2.37, 24.86)**
	No	92 (78.0)	184 (97.9)	Ref	
Herbal medications use	Yes	34 (28.8)	37 (19.7)	1.65 (0.97, 2.83)	**1.97 (1.07, 3.64)**
	No	84 (71.2)	151 (80.3)	Ref	
History of proteinuria	Yes	36 (30.5)	9 (4.8)	8.73 (4.02, 18.97)	**5.16 (2.09, 12.74)**
	No	82 (69.5)	179 (95.2)	Ref	
History of Kidney stones	Yes	10 (8.5)	2 (1.1)	8.61 (1.78, 81.72)	0.67 (0.09, 5.29)
	No	108 (91.5)	186 (98.9)	Ref	
History of anaemia	Yes	57 (48.3)	58 (30.9)	2.09 (1.30,3.37)	**1.80 (1.02, 3.19)**
	No	61 (51.7)	130 (69.1)	Ref	

OR: odds ratio, aOR: adjusted odds ratio, NSAIDS: non-steroidal anti-inflammatory drugs, UTI: urinary tract infection, Ref: reference group, NS: non-significant, OR: odds rati, aOR:adjusted odds ratio

4.6 Stratified analysis

Independent variable: Diabetes Mellitus type 2

Outcome variable: CKD case status

Stratification variable: Presence or absence of hypertension as comorbidity

Stratus 1(Hypertension present)

		CKD status		TOTAL
DM type diagnosis		Present	Absent	
	Yes	20	7	27
	No	37	32	69
TOTAL		57	39	96

Stratum specific OR=**2.47**

Stratum 2 (Hypertension absent)

		CKD status		TOTAL
DM type diagnosis		Present	Absent	
	Yes	11	22	33
	No	50	127	177
TOTAL		61	149	210

Stratum specific OR=**1.27**

MH_{OR}= ((20×32)/96) + ((11×127)/210 =**1.68**
((37×7)/96) + ((50×22)/210

Outcome of testing for interaction between hypertension and type 2 diabetes in the model

Interaction term	OR	95% CI		Coefficient	S.E	Z-statistic	P-value
HTN (Yes/No)*DM (Yes/No)	4.92	1.08	22.29	1.59	0.77	2.06	0.039

Summary

Crude OR=1.95

Stratum 1 OR=2.47

Stratums 2 OR=1.27

MH_{OR}=1.68

% Difference between crude and MH OR: 13.8%

P-value of interaction term: 0.039

Hence: Effect modification is present (Crude OR falls between the stratum-specific OR, P-value of interaction term in the model is significant)

Confounding also may be present: Difference between crude and MH OR is above 10%; this is dealt with in the model.

CHAPTER FIVE

5.0 Discussion

Our study population was middle-aged and had similar proportions of male and female as well as urban and rural residents. While the Kenyan population structure reveals a near equal proportion of males and females adults, majority of Kenyans are rural dwellers (UN, 2017). Our finding of near equal proportions of urban and rural residents could be due to majority of the study participants originating from the capital city, which is the residence of approximately 10% of the entire Kenyan population (World-Bank, 2016). Kenyatta National Hospital, in addition to being the biggest referral hospital in the country also serves the catchment population in the city. Majority had attained at least primary education, which translates to eight years of formal education and above. More than half of the respondents had some form of employment. Our sample included participants originating from majority of the Kenyan Counties, with Nairobi County contributing the biggest proportion. This is likely due to the fact that this is the largest referral facility in the country. Other studies of on CKD in specific conditions had higher proportion of women than in our study (Ambetsa, 2014, Nyamai, 2014).

This health facility-based study revealed a high burden of CKD in this inpatient population, at 39%. Determination of prevalence of CKD among medical inpatients provides a proxy indicator of disease burden in the catchment population of that particular facility when population surveys are not feasible. Similar studies done in different countries reported a lower prevalence of CKD compared to our study; 15.3% in Uganda (Kalima *et al.*, 2015), 13.5% in Botswana (Rwegerera *et al.*, 2017) and 22.3% in the US (Ferris *et al.*, 2009). This could demonstrate a higher disease burden in our settings, as a result of higher prevalence of infectious triggers of renal damage, or differences in the approach of these studies. The Ugandan study, for instance, performed ultrasonography in all the included patients, hence likely increasing specificity and restriction of

their case definition; in our study, only 10% had the imaging done, with features suggestive of CKD present in 5.1%. The US study had a mixed population, but the prevalence of CKD among African Americans, was 27.1%, still lower than our study, suggesting different disease burdens, possible environmental factors underlying the difference or differences in case ascertainment process.

Other studies done in Kenya on prevalence of CKD in specific conditions have also found lower prevalence than in our study; 6.3% in HIV patients on nevirapine-based HAART regimens (Ambetsa, 2014), 17.6% among HIV patients on HAART (Kairu, 2015), 28.7% among patients with rheumatoid arthritis (Said, 2015). Only one had a higher prevalence of 54.5% among ambulatory type 2 diabetic patients (Nyamai, 2014). Our study could have detected patients without a clear underlying risk/predisposing factors, hence higher prevalence. Diabetes is a major risk factor for CKD, therefore could explain the prevalence higher than our study. The CKD cases originated from 27 out of 47 Kenyan Counties, all along the Northern corridor (main highway from Mombasa on the Kenyan coast to Malaba on the Kenya-Uganda boarder). This is likely due to the fact that majority of the Kenyan population live along this particular corridor (World-Bank, 2016). Majority of the CKD cases were male; this differs in other studies globally that show CKD is generally more prevalent in women, although severe forms are higher in men (Takamatsu *et al.*, 2009). One suggested mechanism is role of testosterone and protective function of oestrogen in women (Goldberg & Krause, 2016). The CKD cases were middle-aged, and were significantly older than their non-CKD counterparts. Older age is also a recognized risk factor for CKD (Falodia & Singla, 2012; Kazancioğlu, 2013). The explanation is that renal function generally decreases with age, hence older individuals are more prone to CKD after renal insults. In our study, most of the cases were rural residents. A systematic review and meta-analysis of studies on CKD in Sub-Saharan Africa did not find any difference in prevalence

between rural and urban populations (Stanifer *et al.*, 2015). The Kenya STEPS survey 2015 did not find significant differences between rural and urban prevalence of diabetes and hypertension (MoH-Kenya, 2015), and since majority of the population are rural residents, this could explain higher disease burden in this demographic. Another possible explanation could be affordability; richer, urban dwellers are likely to prefer private hospitals rather than coming to KNH.

Majority of the CKD cases were assigned that status due to presence of derangements for more than three months and moderate or severe anaemia of chronic disease. A cut-off of three months is used to differentiate CKD from AKI; most of the cases of the latter are short-lived and reversible. Anaemia is a common comorbidity of CKD and a marker applied in differentiating CKD from AKI. Anaemia was also the commonest complication among the CKD patients at 54.2%. Another Kenyan study found even a higher of prevalence of anaemia in CKD patients, at 67% (Maina, 2015). The form of anaemia in CKD is usually normocytic, normochromic, and hypoproliferative, and is associated with reduced quality of life, increased cardiovascular disease, hospitalizations, cognitive impairment, and mortality. Different mechanisms have been suggested to explain occurrence of anaemia in CKD, including erythropoietin deficiency, uremic inhibition of erythropoiesis, shortened red cell lifespan and hepcidin excess (Babitt & Lin, 2012). Other electrolyte imbalances in our study included low sodium, elevated potassium levels and abnormal bone metabolism (low calcium or elevated serum phosphate levels). These have been observed in other studies, with hyperkalaemia attributed to reduced kidney function, hyponatremia a consequence of fluid retention and loss of renal regulation of calcium and phosphate homeostasis (Dhondup & Qian, 2017). High prevalence of these abnormalities in our study may point to low early detection and management in clinical settings; failure to properly manage these complications can worsen CKD and quality of life (Van der Walt *et al.*, 2015).

On staging, majority of the CKD cases in our study had mild disease (stage G1 and G2), a quarter had stage G4 or G5 (advanced disease) while one in seven patients had end-stage disease (ESRD). Two previous Kenyan studies found prevalence of ESRD of 32% and 11.5% (Maina, 2015), (Rajula, 2009). These two studies however were focussing on a population of already diagnosed CKD patients primarily, in renal clinics. Another Kenyan study focussing on a population of type 2 diabetes without prior diagnosis of CKD reported a prevalence of ESRD of 0.5% while the Ugandan study reported 4.6% (Nyamai, 2014), (Kalima *et al.*, 2015). Our study was comparable in approach to the Ugandan study and therefore may indicate either higher prevalence in our settings or differences in how case detection was made. Since this is the stage that requires renal replacement therapy, our study provides pilot data for planning population-based surveys for mapping of regional and national burden as well as need for investment in advanced renal treatment infrastructure.

Our study found Male sex, previous history of haematuria, proteinuria anaemia or hypertension and use of herbal medications as factors associated with CKD in this inpatient population. In comparison, a study in India reported association of CKD with anaemia (Singh *et al.*, 2013). Another study in Asia found association with male sex (Lew *et al.*, 2018). Association with urinary proteins has also been reported (Schanstra *et al.*, 2015). Use of herbal medications has been previously associated with acute kidney injury which is a recognized precursor of CKD (Tangkiatkumjai *et al.*, 2015). Other suggested mechanisms of herbal medications role in CKD include direct nephrotoxicity augmented by underlying predisposing conditions such as dehydration; contamination, or adulteration of remedies; inappropriate use or preparation or interactions with other medications (Luyckx, 2012). Haematuria has been identified as frequent manifestation of glomerular disease, and forerunner of CKD (Moreno *et al.*, 2012), and may have a role in screening for early renal damage.

Interaction between hypertension and type 2 diabetes was likely due to the fact that these conditions frequently co-exist in the same patient.

CHAPTER SIX

6.0 Conclusion, Recommendations and Limitations

6.1 Conclusions

- There is a high burden of CKD in medical inpatients at KNH, with our study reporting a prevalence of approximately 4 out of 10 inpatients.
- Anaemia and electrolyte abnormalities are common complication among patients with CKD at the KNH.
- Male sex, prior history of anaemia, haematuria, proteinuria and use of herbal medications were significantly associated with having CKD at KNH.

6.2 Recommendations

- Screening for CKD with dipstick urinalysis should be advised, starting at the lowest level of healthcare provision in Kenya, since the test is simple, inexpensive and easy to interpret (Directorate of curative and rehabilitative services, Ministry of Health).
- Protein or blood in urine on urinalysis, especially in males, should serve as referral criteria for more extensive workup (Directorate of curative and rehabilitative services, Ministry of Health).
- Public education on dangers of herbal medications should be carried out at the national level (Directorate of Preventive and Promotive Health, Ministry of Health and County Health Departments).
- Findings of this study could serve as pilot data for planning for population-based surveys, both in a rural and urban setting, to characterize the burden of CKD in Kenya (Department of Non-communicable Diseases, Ministry of Health).

6.3 Study limitations

Some medical history features (blood/proteins in urine) could have occurred after CKD process had started; this had the potential of distorting the associations. To ensure we captured only symptoms experienced prior to diagnosis, we corroborated the information from the interviews with the medical history captured in the inpatient records. Interpretation of our results does not intend to infer causality; rather the association between the two early symptoms and CKD may have a role in early diagnosis.

There was also possibility of misclassifying AKI as CKD therefore spuriously increasing the disease burden. To minimise this, the study only considered those with reduced GFR or normal GFR with proteinuria and presence of at least one other feature to differentiate it from AKI; we believe this increased the specificity of the diagnostic criteria.

7.0 References

Ambetsa, M. O. (2014). Incidence and risk factors of renal dysfunction among HIV positive patients on nevirapine based regimens at Kenyatta national hospital. . *University of Nairobi*.

Arora, V., Moriates, C., & Shah, N. (2015). The challenge of understanding health care costs and charges. *AMA journal of ethics*, *17*(11), 1046.

Babitt, J. L., & Lin, H. Y. (2012). Mechanisms of Anemia in CKD. *Journal of the American Society of Nephrology : JASN*, *23*(10), 1631-1634. doi: 10.1681/ASN.2011111078

Bello, A. K., Levin, A., Tonelli, M., Okpechi, I. G., Feehally, J., Harris, D., . . . Osman, M. A. (2017). Assessment of Global Kidney Health Care Status. *Jama*.

Bleyer, A. J., Shemanski, L. R., Burke, G. L., Hansen, K. J., & Appel, R. G. (2000). Tobacco, hypertension, and vascular disease: risk factors for renal functional decline in an older population. *Kidney international*, *57*(5), 2072-2079.

Bursac, Z., Gauss, C. H., Williams, D. K., & Hosmer, D. W. (2008). Purposeful selection of variables in logistic regression. *Source code for biology and medicine*, *3*(1), 17.

Chang, A., & Kramer, H. (2012). CKD progression: a risky business. *Nephrology Dialysis Transplantation*, gfs095.

Charan, J., & Biswas, T. (2013). How to calculate sample size for different study designs in medical research? *Indian journal of psychological medicine*, *35*(2), 121.

Chawla, L. S., Eggers, P. W., Star, R. A., & Kimmel, P. L. (2014). Acute kidney injury and chronic kidney disease as interconnected syndromes. *New England Journal of Medicine*, *371*(1), 58-66.

Damien, P., Lanham, H. J., Parthasarathy, M., & Shah, N. L. (2016). Assessing key cost drivers associated with caring for chronic kidney disease patients. *BMC health services research, 16*(1), 690.

Dhondup, T., & Qian, Q. (2017). Electrolyte and Acid-Base Disorders in Chronic Kidney Disease and End-Stage Kidney Failure. *Blood Purification, 43*(1-3), 179-188.

Eckardt, K.-U., Coresh, J., Devuyst, O., Johnson, R. J., Köttgen, A., Levey, A. S., & Levin, A. (2013). Evolving importance of kidney disease: from subspecialty to global health burden. *The Lancet, 382*(9887), 158-169.

Edwards, J. K., Bygrave, H., Van den Bergh, R., Kizito, W., Cheti, E., Kosgei, R. J., . . . Reid, T. (2015). HIV with non-communicable diseases in primary care in Kibera, Nairobi, Kenya: characteristics and outcomes 2010–2013. *Transactions of The Royal Society of Tropical Medicine and Hygiene, 109*(7), 440-446.

Ejerblad, E., Fored, C. M., Lindblad, P., Fryzek, J., McLaughlin, J. K., & Nyrén, O. (2006). Obesity and risk for chronic renal failure. *Journal of the American Society of Nephrology, 17*(6), 1695-1702.

Erek, E., Süleymanlar, G., Serdengeçti, K., Altıparmak, M., Sifil, A., & Seyahi, N. (2007). Registry of the nephrology, dialysis and transplantation in Turkey. *Turkish Society of Nephrology*.

Evans, P. D., & Taal, M. W. (2011). Epidemiology and causes of chronic kidney disease. *Medicine, 39*(7), 402-406.

Falodia, J., & Singla, M. K. (2012). CKD epidemiology and risk factors. *Clinical queries: nephrology, 1*(4), 249-252.

Ferguson, T. W., Tangri, N., Rigatto, C., & Komenda, P. (2015). Cost-effective treatment modalities for reducing morbidity associated with chronic kidney disease. *Expert review of pharmacoeconomics & outcomes research, 15*(2), 243-252.

Ferris, M., Detwiler, R. K., Kshirsagar, A. V., Pierre-Louis, M., Mandhelker, L., & Shoham, D. A. (2009). High prevalence of unlabeled chronic kidney disease among inpatients at a tertiary-care hospital. *The American journal of the medical sciences, 337*(2), 93-97.

Fliser, D., Laville, M., Covic, A., Fouque, D., Vanholder, R., Juillard, L., . . . ERBP, A.-H. W. G. o. (2012). A European Renal Best Practice (ERBP) position statement on the Kidney Disease Improving Global Outcomes (KDIGO) clinical practice guidelines on acute kidney injury: part 1: definitions, conservative management and contrast-induced nephropathy. *Nephrology Dialysis Transplantation*, gfs375.

Germino, G. G., & Guay-Woodford, L. M. (2014). *Chronic renal disease.* Paper presented at the Elsevier Inc.

Ghaderian, S. B., & Beladi-Mousavi, S. S. (2014). The role of diabetes mellitus and hypertension in chronic kidney disease. *J Renal Inj Prev, 3*(4), 109-110.

Goldberg, I., & Krause, I. (2016). The role of gender in chronic kidney disease. *EMJ, 1*(2), 58-64.

Goldstein, S. L., & Devarajan, P. (2011). Acute kidney injury in childhood: should we be worried about progression to CKD? *Pediatric Nephrology, 26*(4), 509-522.

Gonzalez-Bedat, M., Rosa-Diez, G., Pecoits-Filho, R., Ferreiro, A., García-García, G., Cusumano, A., . . . Douthat, W. (2015). Burden of disease: prevalence and incidence of ESRD in Latin America. *Clin Nephrol, 83*(7 Suppl 1), 3-6.

Gosmanova, E. O., & Le, N.-A. (2011). Cardiovascular complications in CKD patients: role of oxidative stress. *Cardiology research and practice, 2011*.

Hill, N. R., Fatoba, S. T., Oke, J. L., Hirst, J. A., O'Callaghan, C. A., Lasserson, D. S., & Hobbs, F. R. (2016). Global Prevalence of Chronic Kidney Disease–A Systematic Review and Meta-Analysis. *PLoS One, 11*(7), e0158765.

Honeycutt, A. A., Segel, J. E., Zhuo, X., Hoerger, T. J., Imai, K., & Williams, D. (2013). Medical costs of CKD in the Medicare population. *Journal of the American Society of Nephrology, 24*(9), 1478-1483.

Hudson, K. B., & Sinert, R. (2011). Renal Failure: Emergency Evaluation and Management. *Emergency medicine clinics of North America, 29*(3), 569-585.

Inoue, T., Iseki, K., Iseki, C., Ohya, Y., Kinjo, K., & Takishita, S. (2009). Heart rate as a risk factor for developing chronic kidney disease: longitudinal analysis of a screened cohort. *Clinical and experimental nephrology, 13*(5), 487-493.

Iseki, K. (2005). Factors influencing the development of end-stage renal disease. *Clinical and experimental nephrology, 9*(1), 5-14.

Jha, V., Garcia-Garcia, G., Iseki, K., Li, Z., Naicker, S., Plattner, B., . . . Yang, C.-W. (2013). Chronic kidney disease: global dimension and perspectives. *The Lancet, 382*(9888), 260-272.

Johnson, D. W., Atai, E., Chan, M., Phoon, R. K., Scott, C., Toussaint, N. D., . . . Wiggins, K. J. (2013). KHA-CARI Guideline: early chronic kidney disease: detection, prevention and management. *Nephrology, 18*(5), 340-350.

Kairu, B. N. (2015). Prevalence of Chronic Kidney Disease among Ambulatory Human Immunodeficiency Virus/acquired Immunodeficiency Syndrome Patients On Antiretroviral Therapy At The Kenyatta National Hospital *University of Nairobi, 2015*.

Kalima, N., Gabriel, B., Muhindo, R., & Muyingo, A. (2015). Chronic kidney disease in patients admitted to the medical ward of Mbarara Regional Referral Hospital in southwestern

Uganda: Prevalence and associated factors. *International Journal of Medicine and Biomedical Research, 4*(2), 107-116.

Karopadi, A. N., Mason, G., Rettore, E., & Ronco, C. (2013). Cost of peritoneal dialysis and haemodialysis across the world. *Nephrology Dialysis Transplantation*, gft214.

Kazancioğlu, R. (2013). Risk factors for chronic kidney disease: an update. *Kidney International Supplements, 3*(4), 368-371.

Köttgen, A., Glazer, N. L., Dehghan, A., Hwang, S.-J., Katz, R., Li, M., . . . Harris, T. B. (2009). Multiple loci associated with indices of renal function and chronic kidney disease. *Nature genetics, 41*(6), 712-717.

Krop, J. S., Coresh, J., Chambless, L. E., Shahar, E., Watson, R. L., Szklo, M., & Brancati, F. L. (1999). A community-based study of explanatory factors for the excess risk for early renal function decline in blacks vs whites with diabetes: the Atherosclerosis Risk in Communities study. *Archives of internal medicine, 159*(15), 1777-1783.

Kwakernaak, A. J., Zelle, D. M., Bakker, S. J., & Navis, G. (2013). Central body fat distribution associates with unfavorable renal hemodynamics independent of body mass index. *Journal of the American Society of Nephrology*, ASN. 2012050460.

Lackland, D. T., Egan, B. M., Fan, Z. J., & Syddall, H. E. (2001). Low Birth Weight Contributes to the Excess Prevalence of End-Stage Renal Disease in African Americans. *The Journal of Clinical Hypertension, 3*(1), 29-31.

Lea, J. P., & Nicholas, S. B. (2002). Diabetes mellitus and hypertension: key risk factors for kidney disease. *Journal of the National Medical Association, 94*(8 Suppl), 7S.

Leung, K. C., Tonelli, M., & James, M. T. (2013). Chronic kidney disease following acute kidney injury—risk and outcomes. *Nature reviews Nephrology, 9*(2), 77-85.

Levey, A. S., Becker, C., & Inker, L. A. (2015). Glomerular filtration rate and albuminuria for detection and staging of acute and chronic kidney disease in adults: a systematic review. *Jama, 313*(8), 837-846.

Levey, A. S., Coresh, J., Balk, E., Kausz, A. T., Levin, A., Steffes, M. W., . . . Eknoyan, G. (2003). National Kidney Foundation practice guidelines for chronic kidney disease: evaluation, classification, and stratification. *Annals of internal medicine, 139*(2), 137-147.

Levey, A. S., Stevens, L. A., Schmid, C. H., Zhang, Y. L., Castro, A. F., Feldman, H. I., . . . Greene, T. (2009). A new equation to estimate glomerular filtration rate. *Annals of internal medicine, 150*(9), 604-612.

Lew, Q. L. J., Allen, J. C., Nguyen, F., Tan, N. C., & Jafar, T. H. (2018). Factors Associated with Chronic Kidney Disease and Their Clinical Utility in Primary Care Clinics in a Multi-Ethnic Southeast Asian Population. *Nephron, 138*(3), 202-213.

Li, P. K. T., Burdmann, E. A., & Mehta, R. L. (2013). Acute kidney injury: global health alert. *Internal medicine journal, 43*(3), 223-226.

Lin, Y.-C., Hsu, C.-Y., Kao, C.-C., Chen, T.-W., Chen, H.-H., Hsu, C.-C., & Wu, M.-S. (2014). Incidence and Prevalence of ESRD in Taiwan Renal Registry Data System (TWRDS): 2005-2012. *Acta Nephrologica, 28*(2), 65-68.

Liyanage, T., Ninomiya, T., Jha, V., Neal, B., Patrice, H. M., Okpechi, I., . . . Knight, J. (2015). Worldwide access to treatment for end-stage kidney disease: a systematic review. *The Lancet, 385*(9981), 1975-1982.

Lozano, R., Naghavi, M., Foreman, K., Lim, S., Shibuya, K., Aboyans, V., . . . Ahn, S. Y. (2013). Global and regional mortality from 235 causes of death for 20 age groups in 1990

and 2010: a systematic analysis for the Global Burden of Disease Study 2010. *The Lancet, 380*(9859), 2095-2128.

Luyckx, V. A. (2012). Nephrotoxicity of alternative medicine practice. *Advances in chronic kidney disease, 19*(3), 129-141.

Luyckx, V. A., & Brenner, B. M. (2010). The clinical importance of nephron mass. *Journal of the American Society of Nephrology, 21*(6), 898-910.

Maina, C. K. (2015). *Prevalence and correlates of anaemia of chronic kidney disease at kenyatta national hospital.* University of Nairobi.

McClellan, W. M., & Flanders, W. D. (2003). Risk factors for progressive chronic kidney disease. *Journal of the American Society of Nephrology, 14*(suppl 2), S65-S70.

McLigeyo, S. (1998). Smoking--an emerging risk factor for renal diseases. *East African Medical Journal, 75*(3), 171-174.

Mirrakhimov, A. E. (2012). Obstructive sleep apnea and kidney disease: is there any direct link? *Sleep and Breathing, 16*(4), 1009-1016.

MoH-Kenya. (2015). The Kenya STEPS survey. Available at http://aphrc.org/wp-content/uploads/2016/04/Steps-Report-NCD-2015.pdf. Last accessed on January 22, 2017.

Moreno, J. A., Martín-Cleary, C., Gutiérrez, E., Rubio-Navarro, A., Ortiz, A., Praga, M., & Egido, J. (2012). Haematuria: the forgotten CKD factor? *Nephrology Dialysis Transplantation, 27*(1), 28-34. doi: 10.1093/ndt/gfr749

Mousavi, S. S. B., Soleimani, A., & Mousavi, M. B. (2014). Epidemiology of end-stage renal disease in Iran: a review article. *Saudi Journal of Kidney Diseases and Transplantation, 25*(3), 697.

Mushi, L., Marschall, P., & Fleßa, S. (2015). The cost of dialysis in low and middle-income countries: a systematic review. *BMC health services research, 15*(1), 506.

Mwololo, C. M. (2013). Anemia and renal dysfunction in patients with ambulatory heart failure at the Kenyatta national hospital *University of Nairobi, 2013*.

Naicker, S. (2010). Burden of end-stage renal disease in sub-Saharan Africa. *Clinical nephrology, 74*, S13-16.

Naicker, S. (2013). End-stage renal disease in Sub-Saharan Africa. *Kidney International Supplements, 3*(2), 161-163.

Naicker, S., Rahmanian, S., & Kopp, J. B. (2015). HIV and chronic kidney disease. *Clinical nephrology, 83*(7 Suppl 1), 32–38. doi:10.5414/cnp83s032

Nugent, R. A., Fathima, S. F., Feigl, A. B., & Chyung, D. (2011). The burden of chronic kidney disease on developing nations: a 21st century challenge in global health. *Nephron Clinical Practice, 118*(3), c269-c277.

Nyamai, S. (2014). The burden of chronic kidney disease in ambulant type 2 diabetes patients at Kenyatta national hospital diabetes outpatient clinics. *University of Nairobi, 2014*.

Nzerue, C. M., Demissochew, H., & Tucker, J. K. (2002). Race and kidney disease: role of social and environmental factors. *Journal of the National Medical Association, 94*(8 Suppl), 28S.

Opiyo, W., Ng'wena, A., & Ofulla, A. (2015). Kidney function predictors and associated serum electrolytes changes in HIV out patients attending Jaramogi Oginga Odinga teaching and referral hospital, Kisumu county, Kenya. *East African Medical Journal, 92*(12).

Orth, S. R., Schroeder, T., Ritz, E., & Ferrari, P. (2005). Effects of smoking on renal function in patients with type 1 and type 2 diabetes mellitus. *Nephrology Dialysis Transplantation, 20*(11), 2414-2419.

Ortiz, A., Covic, A., Fliser, D., Fouque, D., Goldsmith, D., Kanbay, M., . . . Vanholder, R. (2014). Epidemiology, contributors to, and clinical trials of mortality risk in chronic kidney failure. *The Lancet, 383*(9931), 1831-1843.

Perneger, T. V., Whelton, P. K., & Klag, M. J. (1994). Risk of kidney failure associated with the use of acetaminophen, aspirin, and nonsteroidal antiinflammatory drugs. *New England Journal of Medicine, 331*(25), 1675-1679.

Plantinga, L. C. (2013). Socio-economic impact in CKD. *Nephrologie & therapeutique, 9*(1), 1-7.

Pollak, M. R., Genovese, G., & Friedman, D. J. (2012). APOL1 and kidney disease. *Current opinion in nephrology and hypertension, 21*(2), 179-182.

Pradeep, A., Kathariya, R., Raju, P. A., Rani, R. S., Sharma, A., & Raghavendra, N. (2012). Risk factors for chronic kidney diseases may include periodontal diseases, as estimated by the correlations of plasma pentraxin-3 levels: a case–control study. *International urology and nephrology, 44*(3), 829-839.

Radhakrishnan, J., Remuzzi, G., Saran, R., Williams, D. E., Rios-Burrows, N., Powe, N., . . . Venuthurupalli, S. K. (2014). Taming the chronic kidney disease epidemic: a global view of surveillance efforts. *Kidney international, 86*(2), 246-250.

Rajula, A. (2009). *Prevalence Of Hypertension And Adequacy Of Its Control In Chronic Kidney Disease Patients At The Renal Clinic At Kenyatta National Hospital.* University of Nairobi.

Rwegerera, G., Bayani, M., Taolo, E., & Habte, D. (2017). The prevalence of chronic kidney disease and associated factors among patients admitted at princess marina hospital, Gaborone, Botswana. *Nigerian Journal of Clinical Practice, 20*(3), 313-319.

Said, S. S. (2015). Chronic kidney disease in rheumatoid arthritis at Kenyatta National Hospital

University of Nairobi, 2015.

Salvador, G. B., Rodríguez, P. M., Ruipérez, G. L., Ferré, G. A., Cunillera, P. O., & Rodríguez, L. L. (2015). Chronic kidney disease in Primary Health Care: Prevalence and associated risk factors. *Atencion primaria/Sociedad Española de Medicina de Familia y Comunitaria, 47*(4), 236.

Schanstra, J. P., Zürbig, P., Alkhalaf, A., Argiles, A., Bakker, S. J., Beige, J., . . . Dawson, J. (2015). Diagnosis and prediction of CKD progression by assessment of urinary peptides. *Journal of the American Society of Nephrology, 26*(8), 1999-2010.

Singh, A. K., Farag, Y. M. K., Mittal, B. V., Subramanian, K. K., Reddy, S. R. K., Acharya, V. N., . . . Rajapurkar, M. M. (2013). Epidemiology and risk factors of chronic kidney disease in India – results from the SEEK (Screening and Early Evaluation of Kidney Disease) study. *BMC nephrology, 14*, 114-114. doi: 10.1186/1471-2369-14-114

Song, E.-Y., McClellan, W. M., McClellan, A., Gadi, R., Hadley, A. C., Krisher, J., . . . Freedman, B. I. (2009). Effect of community characteristics on familial clustering of end-stage renal disease. *American journal of nephrology, 30*(6), 499-504.

Stanifer, J. W., Maro, V., Egger, J., Karia, F., Thielman, N., Turner, E. L., . . . Patel, U. D. (2015). The epidemiology of chronic kidney disease in Northern Tanzania: a population-based survey. *PLoS One, 10*(4), e0124506.

Staples, A., & Wong, C. (2010). Risk factors for progression of chronic kidney disease. *Current opinion in pediatrics, 22*(2), 161.

Stevens, P. E., & Levin, A. (2013). Evaluation and management of chronic kidney disease: synopsis of the kidney disease: improving global outcomes 2012 clinical practice guideline. *Annals of internal medicine, 158*(11), 825-830.

Stringer, S., Sharma, P., Dutton, M., Jesky, M., Ng, K., Kaur, O., . . . Cockwell, P. (2013). The natural history of, and risk factors for, progressive Chronic Kidney Disease (CKD): the Renal Impairment in Secondary care (RIISC) study; rationale and protocol. *BMC nephrology*, *14*(1), 95.

Su, S.-L., Lu, K.-C., Lin, Y.-F., Hsu, Y.-J., Lee, P.-Y., Yang, H.-Y., & Kao, S.-Y. (2012). Gene polymorphisms of angiotensin-converting enzyme and angiotensin II type 1 receptor among chronic kidney disease patients in a Chinese population. *Journal of Renin-Angiotensin-Aldosterone System*, *13*(1), 148-154.

Subbiah, A. K., Chhabra, Y. K., & Mahajan, S. (2016). Cardiovascular disease in patients with chronic kidney disease: a neglected subgroup. *Heart Asia*, *8*(2), 56-61.

Susantitaphong, P., Cruz, D. N., Cerda, J., Abulfaraj, M., Alqahtani, F., Koulouridis, I., & Jaber, B. L. (2013). World incidence of AKI: a meta-analysis. *Clinical Journal of the American Society of Nephrology*, *8*(9), 1482-1493.

Takamatsu, N., Abe, H., Tominaga, T., Nakahara, K., Ito, Y., Okumoto, Y., . . . Doi, T. (2009). Risk factors for chronic kidney disease in Japan: a community-based study. *BMC nephrology*, *10*(1), 34.

Tangkiatkumjai, M., Boardman, H., Praditpornsilpa, K., & Walker, D. M. (2015). Association of herbal and dietary supplements with progression and complications of chronic kidney disease: A prospective cohort study. *Nephrology*, *20*(10), 679-687.

UN. (2017). Kenya population Structure. Available at https://www.populationpyramid.net/kenya/2017/. Last accessed 11 May 2018.

Van der Walt, I., Swanepoel, C., Mahala, B., & Meyers, A. (2015). Important complications of chronic kidney disease. *South African Medical Journal*, *105*(4), 328-331.

Vanmassenhove, J., Vanholder, R., Nagler, E., & Van Biesen, W. (2013). Urinary and serum biomarkers for the diagnosis of acute kidney injury: an in-depth review of the literature. *Nephrology Dialysis Transplantation, 28*(2), 254-273.

Vikse, B. E., Irgens, L. M., Leivestad, T., Hallan, S., & Iversen, B. M. (2008). Low birth weight increases risk for end-stage renal disease. *Journal of the American Society of Nephrology, 19*(1), 151-157.

Wang, V., Vilme, H., Maciejewski, M. L., & Boulware, L. E. (2016). *The economic burden of chronic kidney disease and end-stage renal disease.* Paper presented at the Seminars in Nephrology.

Webster, A. C., Nagler, E. V., Morton, R. L., & Masson, P. (2017). Chronic kidney disease. *The Lancet, 389*(10075), 1238-1252.

Were, A., & Otieno, L. (1992). Acute renal failure as seen at Kenyatta National Hospital. *East African Medical Journal, 69*(2), 110-113.

World-Bank. (2016). Kenya Urbanization Review. Available at http://documents.worldbank.org/curated/en/639231468043512906/pdf/AUS8099-WP-P148360-PUBLIC-KE-Urbanization-ACS.pdf. Last accessed 11 May 2018.

8.0 Appendices

8.1 Consent Form (English)

Study Title: **Prevalence and factors associated with chronic kidney disease among medical inpatients at the Kenyatta National Hospital.**

Investigator: Dr.Valerian Mwenda (SPH/PGH/FE/06/16)

Resident, Field epidemiology and Laboratory Training Programme,

Ministry of Health/Centers for Disease Control

Phone: 0723992573, Email valmwenda@gmail.com

Supervisors:

1. Professor Willis Owino-Ong'or,

   College of Health Sciences, School of Public Health

   Moi University

   P.O. Box 3900-30100

   Eldoret, Kenya.

   Contacts: Email, owinowillis12@yahoo.com, Cell phone: +254722716598.

2. Dr Gladwell Gathecha,

   Head, Violence and Injuries Prevention Unit, Division of Non-Communicable Diseases

   Ministry of Health-Kenya

   P.O Box 30016-00100

   Contacts: Email: gladwellgathecha@gmail.com, cell phone: +254722771106

Purpose of the research study

The purpose of this study is to determine the number of patients with kidney disease attending the kidney specialist clinic at the Kenyatta National Hospital who have the most severe stage of the disease (also called end-stage kidney disease or kidney failure). The study will also document the economic burden of chronic kidney disease on the patients as well as the hospital. This information will enable the Ministry of Health in planning and resource allocation for people with kidney disease in Kenya.

What you will be asked to do in the study

During your routine clinic attendance, a questionnaire will be administered to you with several questions relating to the study objective. A research assistant will guide you through the process in either English or Kiswahili. Your scheduled appointment time will be put into consideration to minimize any inconveniences to you.

Time required

The administration of the questionnaire will take approximately half an hour.

Risks and Benefits

There are no anticipated risk for your involvement in this study. The potential benefits of the study include providing information to inform resource allocation and improvement of facilities and personnel numbers involved in the care of kidney patients countrywide. There are no direct benefits to you as an individual.

Incentive or Compensation

There is no extra credit or other incentive for participating; therefore, you will not be adversely affected in any way if you choose not to participate.

Confidentiality

Your identity will be kept confidential to the extent provided by law. Your information will be assigned a code number. The list connecting your name to this number will be kept in a locked file in the faculty supervisor's office. Any data stored in a computer database will be pass-word protected and accessible to the principal investigator only. When the study is completed and the data have been analyzed, the list will be destroyed. Your name will not be used in any report or publication.

Voluntary participation

Your participation in this study is completely voluntary. Should you elect to discontinue participation, any information already collected will be discarded. There is no penalty or loss of benefit for choosing not to participate.

Right to withdraw from the study

You have the right to withdraw from the study at any time without consequence or penalty.

Whom to contact if you have questions about the study
If you have any questions about this research, you may call **Dr Valerian Mwenda** on 0723992573, or Email valmwenda@gmail.com.
If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you may contact the Moi University Institutional Research and Ethics Committee (IREC), contacts: Email: irecoffice@gmail.com , telephone: 0787723677.

Agreement
If you wish to participate in this study, please sign the form below. A signature will indicate agreement to participate.

Participant's Name: (Print) _____

Signature _____ (Date) _____

Interviewer Name (print) _____

Signature _____ (Date) _____

8.2 Consent form (Kisawhili)

Idhini Ya Kushiriki Utafiti

Utangulizi
Jina langu ni daktari Valerian Mwenda, mwanfunzi wa uzamifu katika chuo kikuu cha Moi, shule ya afya ya umma, chini ya wizara ya afya. Nafanya utafiti kuhusu idadi ya wagonjwa wenye ugonjwa wa figo na madhara yake kiuchumi kwa wagonjwa hawa. Utafiti huu utaiwezesha wizara ya afya kuweka mikakati kabambe kupambana na igonjwa wa figo hapa nchini pamoja na kurahisisha matibabu yake.

Taratibu zitakazofuatwa
Uikiubali kushiriki utafiti huu, nitakuuliza maswali kadha wa kadha, kulingana na taratibu ya maswali ambayo imetayarishwa kabla.

Haki yako kama mshiriki katika utafiti huu-Ushiriki wako katika utafiti huu ni wa kujitolea. Hata ukichagua kushiriki au ukatae kushiriki haitaathiri matibabu yako. Una uhuru wa kujiondoa katika utafiti huu wakati wowote. Una uhuru wa kuuliza maswali kabla ya kutia sahihi katika fomu ya idhini na wakati wa utafiti. Maswala yote yatahifadhiwa kwa siri wakati wote.

Hasara za ushiriki - Hakuna hasara yoyote utakayopitia au kupata.

Manufaa ya kushiriki-Mwishoni mwa utafiti huu, nitawasilisha matokeo ya utafiti katika idara ya magonjwa yasiyoambulizwa ya wizara ya afya. Habari zozote muhimu zitakazotokana na utafiti na ambazo zitafanya tiba kuwa bora zitawasilishwa kwa wadau wote kwa njia mwafaka.

Siri- Habari zote zitakazokusanywa wakati wa utafiti zitahifadhiwa kwa siri. Ni watafiti pekee ndio wanaoweza kufikia habari za kibinafsi. Habari zitakazokusanywa zitaandikwa na kuainishwa bila kutaja washiriki.
Ikiwa una swali lolote wakati wa utafiti, unaweza kuwasiliana na wafuatao: DKT. Valerian Mwenda, chuo kikuu cha Moi, idara ya mafundisho ya afya ya umma, Simu ya mkono 0723-992573 ***AU*** mwenyekiti, kamati inayoshughulikia maadili, Chuo kikuu cha Moi (IREC) Nambari ya simu: 0787723677, au barua pepe irecoffice@gmail.com.
Kabla sijakuhusisha katika utafiti wangu, Naomba utie sahihi katika fomu ya idhini iliyopo hapo chini. Fomu hii ya idhini haitahusishwa na majibu yako.
Kauli ya ridhaa: Nimesoma habari hapo juu na nimepata majibu ya maswali yoyote

SAHIHI…….TAREHE……

JINA …….

MKUU WA UCHUNGUZI

SAHIHI

……TAREHE……

JINA ……

Ahadi ya mhusika

Ninakiri ya kwamba nimeelezwa na kufafanuliwa muktadha wa utafiti huu, na nimeelewa ya kwamba ni hiari yangu kuhusika. Pia, nimeelewa ya kwamba naweza kujiondoa kwenye utafiti huu wakati wowote bila kuhatarisha matibabu yangu. Aidha, nimeelewa ya kwamba maswali yote nitakayozua kuhusiana na utafiti huu yatajibiwa na mtafiti mkuu, Dkt Valerian Mwenda kupitia simu ya rununu) 0723992573, au barua pepe valmwenda@gmail.com. Pia, ninaweza kuwasiliana na kamati ya maadili ya kisayansi ya chuo kikuu cha Moi, nambari ya simu 0787723677, au barua pepe irecoffice@gmail.com.

8.3 Questionnaire

A) SECTION A: SOCIO-DEMOGRAPHICS

Question 1 What is the sex of the participant? 1. Male ☐ 2. Female ☐

Question 2

How old are you (in years)? ----------

Question 3

What is your marital status?

1. Single ☐ 2. Separated ☐ 3. Divorced ☐ 4. Widowed ☐ 5. Married ☐

Question 4

What is your employment status?

1. Full-time work ☐ 2. Part-time work ☐ 3. Unemployed ☐ 4. Homemaker ☐ 5. Retired ☐

Question 5

What is the highest level of education you completed?

1. No formal education ☐ 2. Primary incomplete ☐ 3. Primary complete ☐ 4. Secondary incomplete ☐ 5. Secondary complete ☐ 6. College and above ☐

Question 6

Where do you live?

1. Rural area ☐ 2. Urban area (town or city) ☐

Question 7

Which county have you lived in the last six months or more?

_____

SECTION B) ASSOCIATED FACTORS

We will ask you several questions on symptoms you experienced before this admission. If you already have been diagnosed with kidney disease, we will ask you symptoms that you experienced before the diagnosis was made.

Question 8

Have you ever been diagnosed with diabetes? 1. Yes ☐ 2. No ☐

If yes, duration since diagnosis (years)

<1 year ☐ 1-5 years ☐ 6-10 years ☐ >10 years ☐

Question 9

Have you ever been diagnosed with hypertension? 1. Yes ☐ 2. No ☐

If yes, duration since diagnosis <1 year ☐ 1-5 years ☐ 6-10 years ☐ >10 years ☐

Question 10

Do you have a first degree relative with kidney disease? 1. Yes ☐ 2. No ☐

If yes to number 11 above, which relative has the disease? 1. Parent ☐ 2. Sibling ☐ 3. Other ☐

Question 12

Have you ever used tobacco? 1. Yes ☐ 2. No ☐

Question 13

Have you ever used alcohol? 1. Yes ☐ 2. No ☐

Question 14

Have you ever been diagnosed with a stroke? 1. Yes ☐ 2. No ☐

Question 15

Have you ever been diagnosed with heart failure? 1. Yes ☐ 2. No ☐

Question 16

Have you ever suffered a heart attack? 1. Yes ☐ 2. No ☐

Question 17

Have you ever been diagnosed with blood circulation problems in your legs (swelling or informed you have a blood vessel/circulation problem? 1. Yes ☐ 2. No ☐

Question 18

Have you ever been told you have protein in your urine? 1. Yes ☐ 2. No ☐

Question 19

Have you ever been told you have anaemia or have low blood or hemoglobin? 1. Yes ☐ 2. No ☐

Question 20

Have you ever been diagnosed with cancer? 1. Yes ☐ 2. No ☐

If yes, how long ago? <1 year ☐ 1-5 years ☐ 6-10 years ☐ >10 years ☐

Which organ? _____

Treatment? Yes ☐ No ☐

Question 21

Have you ever been diagnosed with kidney disease? 1. Yes ☐ 2. No ☐

If yes, how long ago? <1 year ☐ 1-5 years ☐ 6-10 years ☐ >10 years ☐

Question 22

Have you ever been diagnosed with kidney stones? 1. Yes ☐ 2. No ☐

Question 23

Have you ever had recurrent urinary tract infections (2 or more episodes in 6 months)? 1. Yes ☐ 2. No ☐

Question 24

Have you ever had a kidney transplant? 1. Yes ☐ 2. No ☐

Question 25

Have you ever passed bloody urine? 1. Yes ☐ 2. No ☐

Question 26

(Females only) Have you ever lost a pregnancy? 1. Yes ☐ 2. No ☐

If yes, how long ago? <1 year ☐ 1-5 years ☐ 6-10 years ☐ >10 years ☐

Question 27

(Females only) Have you ever suffered high blood pressure during pregnancy? 1. Yes ☐ 2. No ☐

Question 28

(Men only) Have you been told you have prostate enlargement? 1. Yes ☐ 2. No ☐

If yes, how long ago? <1 year ☐ 1-5 years ☐ 6-10 years ☐ >10 years ☐

Question 29

Have you been diagnosed with HIV? 1. Yes ☐ 2. No ☐

Are you on HAART? Yes ☐ No ☐

If yes, which drugs ……

Question 30

Have you ever used the following medications for more than a month?

a) NSAIDS (brufen, diclofenac, Aceclofenac, meloxicam) 1. Yes ☐ 2. No ☐
b) Herbal medications 1. Yes ☐ 2. No ☐

SECTION C) LABORATORY RESULTS (To be filled by the interviewer from the medical file).

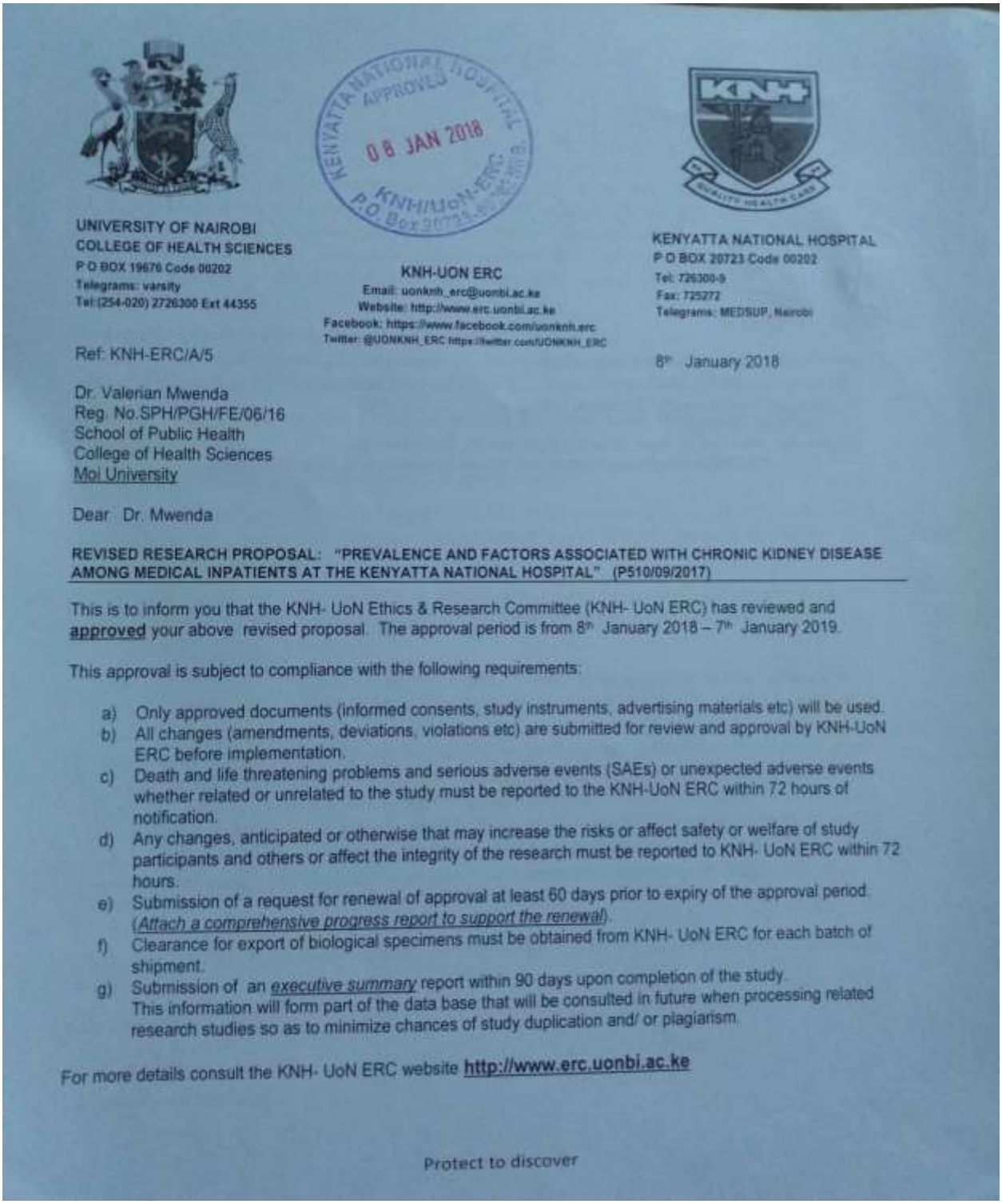
Test	**Done**		**If yes, indicate the level**
	Yes	**No**	
Hemoglobin level (g/dl)			
Creatinine levels (mmol/l)			
Serum calcium (mmol/l)			
Serum phosphate (mmol/l)			
Urinary protein (g/dl)			

SECTION D) IMAGING MODALITIES

Imaging modalities	**Done**		**If yes, main finding**
	Yes	**No**	
Renal ultrasound			

8.4 Ethical Approval (KNH/UoN ERC)

Kenyatta National Hospital/University of Nairobi Ethics and Research Committee (ERC)



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

KENYATTA NATIONAL HOSPITAL APPROVED 08 JAN 2018 KNH/UoN-ERC P.O Box 20723-00202

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

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

Ref: KNH-ERC/A/5

8th January 2018

Dr. Valerian Mwenda
Reg. No.SPH/PGH/FE/06/16
School of Public Health
College of Health Sciences
Moi University

Dear Dr. Mwenda

REVISED RESEARCH PROPOSAL: "PREVALENCE AND FACTORS ASSOCIATED WITH CHRONIC KIDNEY DISEASE AMONG MEDICAL INPATIENTS AT THE KENYATTA NATIONAL HOSPITAL" (P510/09/2017)

This is to inform you that the KNH- UoN Ethics & Research Committee (KNH- UoN ERC) has reviewed and **approved** your above revised proposal. The approval period is from 8th January 2018 – 7th January 2019.

This approval is subject to compliance with the following requirements:

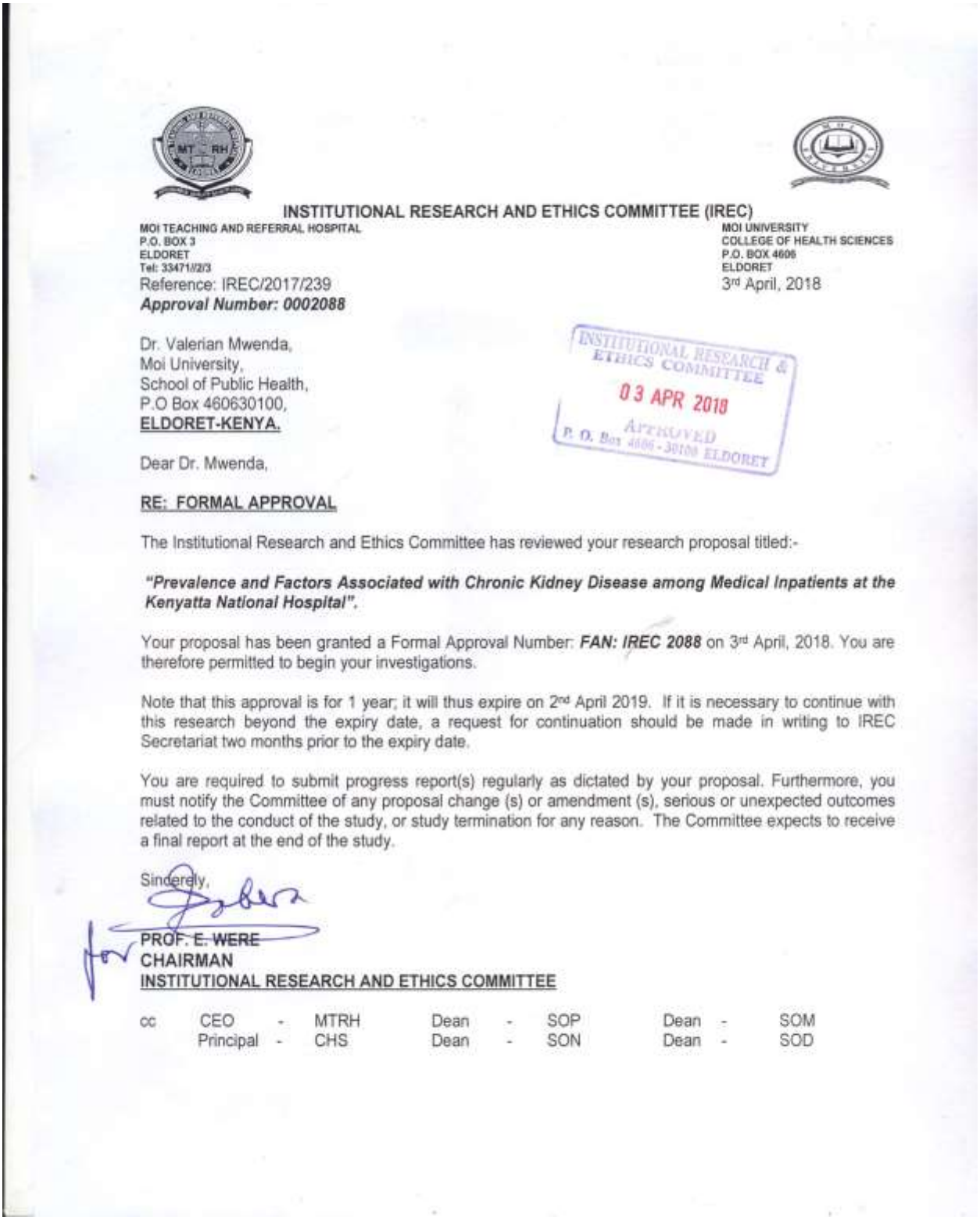
a) Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
b) All changes (amendments, deviations, violations etc) are submitted for review and approval by KNH-UoN ERC before implementation.
c) Death and life threatening problems and serious adverse events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

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

Protect to discover

8.5 Ethical Approval (IREC)

Moi University Institutional Research and Ethics Committee (IREC)



INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471//2/3

MOI UNIVERSITY
COLLEGE OF HEALTH SCIENCES
P.O. BOX 4606
ELDORET

Reference: IREC/2017/239
Approval Number: 0002088

3rd April, 2018

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
03 APR 2018
APPROVED
P. O. Box 4606 - 30100 ELDORET

Dr. Valerian Mwenda,
Moi University,
School of Public Health,
P.O Box 460630100,
ELDORET-KENYA.

Dear Dr. Mwenda,

RE: FORMAL APPROVAL

The Institutional Research and Ethics Committee has reviewed your research proposal titled:-

"Prevalence and Factors Associated with Chronic Kidney Disease among Medical Inpatients at the Kenyatta National Hospital".

Your proposal has been granted a Formal Approval Number: ***FAN: IREC 2088*** on 3rd April, 2018. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 2nd April 2019. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc CEO - MTRH Dean - SOP Dean - SOM
Principal - CHS Dean - SON Dean - SOD