PREVALENCE OF VENTRICULAR SYSTOLIC CARDIAC DYSFUNCTION AMONG PAEDIATRIC PATIENTS WITH CHRONIC KIDNEY DISEASE AT KENYATTA NATIONAL HOSPITAL - A HOSPITAL BASED CROSS-SECTIONAL STUDY.

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DECLARATION

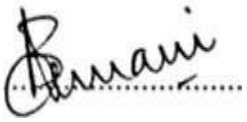
This dissertation proposal is my original work and has not been presented for the award of any degree in any other university.

Signature:  **Date:** 20/01/2023

Dr. Priscilla Wairimu Ngacha

SUPERVISORS' APPROVAL

This dissertation has been presented with our full approval as supervisors.

Signature:  **Date:** 20/01/2023

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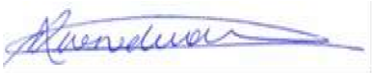
Signature:  **Date:** 20/01/2023

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DEDICATION

To Mum, Dad and My son Edward.

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LIST OF ABBREVIATIONS

BP- Blood Pressure

BMI- Body Surface Area

CKD - Chronic Kidney Disease.

CKD-BMD - Chronic kidney disease- bone mineral disease.

CVD- Cardiovascular Disease

ECHO- Echocardiogram

ECG- Electrocardiogram

ESRD- End-stage Renal Disease

HD – Haemodialysis.

HR- Heart Rate

LVD- Left Ventricular Dysfunction

LVH- Left Ventricular Hypertrophy

LVMI- Left Ventricular Mass Index

LVM- Left Ventricular Mass

KNH- Kenyatta National Hospital

KDIGO - Kidney Disease Improving Global Outcomes.

NKF/KDOGI -The National Kidney Foundation, Kidney Disease Outcome Quality Initiative

Pmarp - Per million age-related population.

Pmcp - Per million children population.

RRP- Renal Replacement Therapy

RVD- Right Ventricular Dysfunction

TAPSE Tricuspid Annular Planar Systolic Excursion

OPERATIONAL DEFINITIONS.

Paediatric Chronic kidney disease (CKD): Chronic Kidney Disease diagnosis as found in the hospital records of study subjects which will include either and/or

- Histological or radiological diagnosis of chronic kidney disease (CKD).
- Estimated glomerular filtration rate (eGFR) of <60 mL/ min/1.73 m^2 for at least 3 months.

Elevated Blood Pressure: systolic or diastolic blood pressure above 95th percentile for age, gender and height.

Cardiac Dysfunction:

Echo Features:

Left ventricular hypertrophy:

LVMI above the 95th percentile for age, gender

Left ventricular systolic dysfunction

Ejection fraction <54%
Fractional shortening <28%

Right Ventricular Systolic dysfunction:

Tricuspid annular plane systolic excursion (TAPSE) <1.6cm adjusted for age, gender and BSA.

Fractional Area Change (%FAC)- <35%

Electrocardiographic features:

QRS duration <3yrs > 70ms, 3-8 yrs> 80ms, 8-12 yrs> 90ms, >12 yrs> 100ms

Corrected QT interval (QTc)- >0.44 sec

Left Ventricular Hypertrophy- (sV1+rV6/V5) > 35 mm

ABSTRACT

Study Background: Chronic Kidney Disease is currently coming to light as a global issue, and with heightened awareness about kidney diseases there is a greater detection of children living with CKD. The risk of developing cardiovascular complications is increased due to the early onset of the disease and longevity of the children. Prevalence of cardiovascular complications in these children with CKD is reported to be low, <3% in Africa. Cardiovascular disease, if not detected and treated early, correlates with worsening morbidity and poor life quality. Increased mortality has also been noted in these children.

Primary objective: To determine the prevalence of ventricular systolic cardiac dysfunction in paediatric patients with Chronic Kidney Disease aged 3 months to 18 years at Kenyatta National Hospital.

Study design and site: Hospital based cross-sectional study.

Participants and Methods: The study population comprised of 49 children recruited from the Kenyatta National Hospital peadiatric and adult renal units, renal clinics and wards. The Inclusion criteria was any child aged 3months-18 years with chronic kidney disease as per the NFK/KDIGO criteria and whose consent and assent (where applicable) was obtained. The exclusion criterion was any child with cardiac disease that was diagnosed prior to the chronic kidney disease diagnosis. Sampling was by consecutive recruitment and once screened and enrolled, data was collected using a structured questionnaire. The blood pressure and anthropometric measurements were then taken and Basal surface area calculated. Transthoracic Echocardiogram and Electrocardiogram was then done for each patient. The outcomes of interest on echocardiogram were left ventricular hypertrophy defined as LVMI> the 95th percentile for age, gender and BSA. Ventricular systolic dysfunction defined as left ventricular systolic dysfunction measured by ejection fraction<54% and fractional shortening <28%.; right ventricular systolic dysfunction measured by Tricuspid annular plane systolic excursion (TAPSE)<1.6cm adjusted for age gender and BSA, Fractional area change (%FAC) < 35%. All measurements taken were adjusted for age gender and BSA using the Bostons' childrens hospital Z score charts. Outcome of interest on electrocardiogram were Corrected QT interval >0.44sec, Left Ventricular Hypertrophy (sV1+rV6/V5)>35mm, QRS duration <3yrs > 70ms,

3-8 yrs> 80ms, 8-12 yrs> 90ms, >12 yrs> 100ms.

Data Management and Analysis: Data collected was entered into a case record from. Analysis was done using STATA version 15. Descriptive characteristics will be analysed and summarized into tables and charts. Statistical associations and amount of risk between a patient's time of diagnosis, hypertensive state and renal replacement therapy and developing ventricular systolic dysfunction was analysed using the chi-square test and binary logistic regression.

Results: 49 children with chronic kidney disease were enrolled into the study, with 28 male and 21 female with a male to female ratio of 1.3:1. The age ranged from 7-216 months, with a median age of 132 months (IQR 72,192). Majority of the children were aged between 12-18 years (40.82%). Many of the children 35(74.4%) had a duration of illness of <3years. Most of the children were on hypertensive treatment 39(81.3%) while 36(73.47) were found to be hypertensive. A total of 16(32.7%) were on renal replacement therapy, with 12(75%) of these being on hemodialysis. The Prevalence of Ventricular Systolic Cardiac Dysfunction on ECHO and or ECG was 44 (89.8% (95%CI 77.1,95.8)) with 42% (87.71%) being diagnosed on ECHO. Left Ventricular hypertrophy was found in 38(77.5%) of the children.

Conclusion: Cardiac dysfunction was highly prevalent in children with CKD. Left ventricular hypertrophy was found to be high (78% (95%CI,63.3,87.4)) in our patients. Right Ventricular systolic dysfunction was higher in our patients with CKD than left ventricular systolic dysfunction. Most of the patients studied were found to be hypertensive (73.5%) despite being on blood pressure medication (81%)

1.0. INTRODUCTION

1.1 Background.

Chronic Kidney Disease (CKD) is a clinical condition that affects multiple systems in the body and is characterized by an unalterable decline of renal function which then rapidly advances to end-stage renal disease (ESRD).

Currently, CKD is an emerging global issue and with increased awareness about kidney diseases, there is a greater detection of children with CKD. The CKD prevalence in Africa is currently unknown due to inadequacy of renal registries, though the estimates point to a significant burden especially in those aged 20-50 yrs. of age. (1), similarly the CKD prevalence among Kenyan children is unknown.

CKD gradually leads to major health complications, and has been recognized as an independent risk factor of cardiovascular disease. (2)

The National Kidney Foundation, Kidney Disease Outcome Quality Initiative (NKF/KDOQI) defines CKD as:

Table 1. NKF/KDOQO criteria for the definition of CKD(3)

1. Kidney damage for>3 mo., as defined by structural or functional abnormalities of the kidney, with or without decreased GFR, manifested by 1 or more of the following features:
   •Abnormalities in the composition of the blood or urine
   •Abnormalities in imaging tests
   •Abnormalities on kidney biopsy
2. GFR60 mL/min/1.73 m2for > 3 months with or without the other signs of kidney damage described above.

The National Kidney Foundation, Kidney Disease Outcome Quality Initiative (NKF/KDOGI) workgroup classification for patients with CKD older than two years is shown in table 2 below.

Table 2: NFK/KDOQI Classification of the staging of CKD for children above 2 yrs of age(3)

Stage	**GFR(ml/min/1.73m^2)**	**Description**
Stage 1 disease	≥90	Kidney damage with normal/increased GFR
Stage 2 disease	60 and 89	Kidney damage with mild reduction GFR
Stage 3 disease	30 and 59	Moderate reduction of GFR
Stage 4 disease	15 and 29	Severe reduction of GFR
Stage 5 disease	< 15(or dialysis)	Kidney Failure

These children with chronic renal failure develop various complications, and are more susceptible owing to early age of onset of their condition and increased longevity. The strict control of their diet, metabolic parameters, regular medication use, and most importantly the avoidance of nephrotoxic drugs can prevent them from progressing into End-Stage Renal Disease. Children with CKD remain asymptomatic early in the disease. As the disease progresses some of the complications seen in patients with CKD are, growth failure, malnutrition, metabolic acidosis, anaemia, hypertension, fluid overload, atherosclerosis, left ventricular hypertrophy, and congestive heart failure among others. In the paediatric population, cardiovascular complications like Hypertension, Left Ventricular Dysfunction, Atherosclerosis are rarely seen (<3%) (4), while the global mortality rate is about 30 times more in children diagnosed with CKD than the age-matched population (5).

Non-invasive methods are used for diagnosing cardiovascular disease. Echocardiography is considered the gold standard non-invasive technique in the diagnosis of CVD in CKD. Electrocardiography is also used as an investigative tool to diagnose arrhythmias, atrial and ventricular heart enlargement in patients with CKD. These changes in electrocardiography may be due to the presence of electrolyte imbalances such as hyperkalaemia, hypocalcaemia while cardiac enlargement such as left and right ventricular hypertrophy is also seen as a complication in patients with CKD. Studies looking at the cardiovascular risks and prevalence of cardiovascular dysfunction among Kenyan children living with CKD disease are yet to be conducted. Thus this study is designed to determine the cardiac dysfunction with a focus on the ventricular systolic function and electrocardiographic changes, and some of the associated risk factors prevalent amongst children with CKD.

2.0. LITERATURE REVIEW

2.1. Prevalence of Chronic Kidney Disease

Chronic Kidney Disease (CKD) is a common worldwide problem and is rapidly increasing at an annual growth rate of 8% (1). The increase can also be attributed to an increased awareness of kidney diseases.

The CDC has reported 16.85/1000 CKD cases in the general population aged > 20 years in America. This is a 15.9% increase in the years 1999-2004 versus 1988-1994(National Health and Nutrition Examination Survey). The CKD incidence rate has increased by 1.1% (355.4 per million populations) as per the US Renal Data System 2011 annual report (2).

In the Ital Kid study that was conducted across a population base of 16.8 million children in Italy, the CKD mean incidence rate per million age related population was 12.1 and 74.7 per million age-related population point prevalence(6). Hypo dysplasia with or without urinary tract malformations was the commonest cause of CKD at 57.6%. while glomerular disease was at 6.8%.

Kuwaits' incidence/prevalence rates of children with CKD are possibly due to genetic and hereditary factors (consanguinity). The mean incidence of CKD in the paediatric population was 38.2 pmc per year, and peak incidence of 55 pmc per year. Omani data in a study carried out between 2004-2015 shows a mean incidence rate of 24.0 per million child population in children with CKD.(7), (8)

G. Abraham et. Al. reports that the prevalence of CKD in Southeast Asia (India, Pakistan Sri Lanka, Nepal, Afghanistan, Bangladesh) is rapidly increasing with India sighted as a hot spot due to consanguinity, poor maternal nutrition which leads to low birth weight(LBW)s and poor hygienic environmental condition among other contributors. The prevalence of paediatric CKD in India(n=1287) was 32.6% being due to chronic glomerulonephritis and 10.6% being due to unknown causes (9).

In Africa, data determining paediatric CKD prevalence is scarce. In a retrospective study conducted in a third level hospital in Enugu, Nigeria 3002 patient files were reviewed and found a prevalence of 14.9%pmcp with an incidence of 3.0 cases pmcp. Glomerular disease was found to be the most common aetiology (63.6%)(5). In Cameroon, Douala general hospital 103 patient records were studied, 15.5% (n=16) accounted for CKD cases, and of these, Chronic glomerulonephritis and urologic malformations mainly posterior urethral valves were the main causes of CKD.(10)

The prevalence of CKD amongst Kenyan children is unknown and there are no reliable statistics on the prevalence of CKD in Africa and other developing countries around the world due to poor renal registries.

2.2. Cardiovascular Dysfunction in Chronic Kidney Disease

Cardiac and Vascular complications (Cardiovascular disease) are seen to start early in CKD before the onset of ESRD. This is due to the various risk factors that the paediatric CKD population face as a result of the long duration of illness.

It is a growing problem that largely contributes to the morbidity, poor life quality, and mortality of CKD patients. This is mainly due to poor treatment and follow-up of both the CKD and cardiac complications in patients within Sub-Saharan Africa(11).

Survival of children with CKD is low with the lifespan of children on RRT being about 50 years lower and that of transplant patients being 25 years lower than that of an age-matched population. (4). In Denmark, Groothoff et al found, of 381 CKD children aged 0-14 years with ESRD the leading cause of death was cerebrovascular accidents while Cardiovascular disease (congestive heart failure, cardiac arrest secondary to arrhythmias) in those on renal replacement therapy (RRT) was the major cause of death(12). CVD has remained the 2nd most common cause of death in children on RRT or after transplantation, according to the USRDS, approximately 20–25% of all the paediatric CKD deaths. (4). Cardiovascular death is commonly due to cardiac arrest followed by arrhythmias and cardiomyopathies (dilated and hypertrophic) respectively. This is mainly seen in those undergoing prolonged dialysis unlike in adults where death is mainly secondary to congestive heart failure or coronary artery disease.

In a study conducted at the University of Nigeria teaching hospital by Adiele et al 24 paediatric patients with CKD aged 6-17 years were studied using an echocardiogram as a tool. They found cardiac abnormalities in 91.7% (n=24). Left ventricular hypertrophy (50.0%) was the most common. It was defined as LVMI $\geq$124.21 g/m2 with 8 (66.6%) of the 12 having eccentric hypertrophy which presents as high LVMI and a low relative wall thickness (RWT) <0.45 and 4 (33.3%) having concentric hypertrophy which presents as high LVMI and high relative wall thickness (RWT) > 0.45. They therefore concluded, in the paediatric population eccentric left ventricular hypertrophy was more prevalent than concentric hypertrophy. (11).

They also assessed both the Left Ventricular Systolic Function (LVSF) and the Left Ventricular Diastolic Function (LVDF). Assessment of LVSF was by ejection fraction (EF) and fraction shortening (FS) while the LVDF was assessed using Trans-mitral early diastolic (E) and late diastolic (A) wave peaks ratio (E/A ratio). The study found that LV diastolic dysfunction was more in these paediatric patients with CKD unlike in the adult population where LV systolic dysfunction was most commonly seen. Left Ventricular hypertrophy was also found to be more prevalent in Sub-Saharan Africa due to factors such as sub-standard health services, poor health-seeking behaviour, and extreme poverty levels. (22). These factors all contribute to the patient going for long periods with poorly managed hypertension.

Chavers BM et al studied data of 155 children (0.7-18 years) diagnosed with CKD, 24% were found to have cardiac disease (left ventricular hypertrophy, congestive heart failure, decreased left ventricular function and cardiomyopathy (17%, 8%2%, 2% respectively). Echocardiogram was used to diagnose Left ventricular hypertrophy/enlargement in 72% of the children studied. Ninety-Two Percent of all studied patients were found to have cardiovascular risk factors(13). Echocardiography, was found to have been performed in only 55 patients in the study, it was not clear why it was not routinely done in all patients diagnosed with CKD.(13)

A retrospective study conducted by Mitsenefes et al on 64 patients (20 months to 22 years) on RRT to evaluate the LV mass (LVM) and geometry using echocardiography found 48(75%) children had LVH. Eighty percent had abnormal LV geometry; 39% had eccentric hypertrophy, 5% had concentric remodelling. It was noted that 41% had severe LVH which was defined as a LVMI > $51\ g/m^{2.7}$.(14)

Right Ventricular dysfunction in children with CKD has been rarely studied in Africa. In Nigeria, Peter ID et al studied the mean pulmonary arterial pressures and RV dysfunction in patients with CKD, he found that the prevalence of RV dysfunction was 9.5%(n=21) and was seen in those who had not received RRT. Patients with RV dysfunction were found to have lower TAPSE than the controls (2.22 ± 0.5 cm *vs*. 2.42 ± 0.3 cm). In this study, the TAPSE values were compared to published normal values for age and noted to be impaired if below the normal range for age. (15). There are no available studies that discuss the percentage fraction change in children with CKD.

2.3. The role of modifiable risk factors

Modifiable risk factors under scrutiny in this study are hypertension, duration of illness, and length of dialysis management. Mitfenes et al. found, patients undergoing chronic RRT needed better BP control which is paramount in the prevention/improvement of LVH.(14)

Wilson A. et al conducted a study looking at the cross-sectional data of the first follow up visits during the CKiD study, they found that of 250 participants, 46%(n=115) were hypertensive, thus showing that at least half of the paediatric patients with CKD have cardiovascular risk factors early in the disease and this may be well before they progress to ESRD.

Similarly, from the same study (CKiD), it was found that out of 275 children receiving antihypertensive medication 36% (n=98) had uncontrolled blood pressures thus were at increased risk of developing cardiovascular disease despite management for their hypertensive state. (16)

In Poland, the prevalence of hypertension among paediatric children with ESRD was studied and found that 78% had hypertension with 17% of this demonstrating LVH. These results were compared to a study done a decade earlier where they found 64% of the paediatric patients with CKD having hypertension. The study concluded that hypertension was prevalent in CKD patients but it was still underdiagnosed and undertreated thus increasing the prevalence of cardiac dysfunction in this population. (17)

B. Chavers et al carried out a cross-sectional analysis on 656 (0-18yrs) children on haemodialysis in the US and found a cardiovascular risk factor in 92% of these patients. Sixty-three percent of these were found to be hypertensive. Cardiac disease was diagnosed in 24% of the patients. They also found that about 30% of patients with hypertension and/or anaemia and were receiving RRT were diagnosed with cardiac disease. (13)

2.4. Use of Echocardiography and Electrocardiography as investigative modalities

Echocardiography is deemed to be the gold standard non-invasive technique in the diagnosis of cardiovascular disease.(14) Two-dimensional Transthoracic Echocardiography (2D-ECHO), has been used to define significant cardiovascular complications in paediatric patients with CKD especially those undergoing RRT(14). A cross-sectional data analysis by Chavers et al. of all US paediatric (0.7–18 years) maintenance haemodialysis patients was performed, they found that of 69% (n=155) patients who were tested, echocardiogram was used in 35 % of the patients and electrocardiogram in 33%, of these, left ventricular hypertrophy/enlargement was diagnosed. Echocardiogram was able to diagnose LVH in 72 % of patients tested while electrocardiogram diagnosed in only 15 % of patients(13). Thus ECHO is a highly sensitive investigative method for the diagnosis of LVH.

Echocardiography provides a non-invasive investigative tool that enables one to look at the geographical/anatomic structure and function of the heart and vessels. Echocardiography can identify

early signs of ventricular dysfunction i.e. LVH and thus prevent severe cardiac disease in this high-risk paediatric population it is also used to diagnose systolic dysfunction in patients with advanced cardiac disease by measuring the ejection fraction.(18) and fractional shortening.

M. Chinali et.al. studied the cardiac morphology and function of 272 children with CKD using echocardiogram, LVM was found to be much higher in CKD patients mainly due to a relatively higher LV wall thickness (0.49 ± 0.07) versus (0.34±0.05 (controls). They also found that LVH was more common in the CKD patient and geometry assessment was found to be preferentially concentric (65%). Assessment of systolic function in this patients showed LV ejection fraction within normal ranges (56%-75%) in the CKD patients group (19) .

Echocardiogram is also used to assess RVSF, assessment of the Tricuspid annular plane systolic excursion using M-Mode, is a simple yet specific method used and it excellently correlates with the right ventricular ejection fraction(RVEF)(20). Percent fractional area change (%FAC) is the measurement for Right ventricular ejection fraction (RVEF). It is calculated as (RVEDA − RVESA)/RVEDA where the RV end-diastolic area (RVEDA) and RV end-systolic area (RVESA) are measured. The limitation of percentage FAC, is a great inter-observer variability, this is caused by difficulties in the delineation of the RV lateral wall. (20)

Electrocardiogram(ECG) is also an important non-invasive investigative tool in these patients as 30% of this population die from cardiac arrest. (21). In a cross-sectional study carried out in Saudi Arabia on 20 paediatric patients on regular RRT, they found at least 50% of these had a prolonged QT interval that may progress to ventricular fibrillation resulting in sudden death. (21). Some of the other changes that are seen on ECG in children with CKD are arrhythmias i.e. tachycardia, tall/peaked T waves and widened QRS due to hyperkalaemia, Long Controlled QT (QTc) due to hypocalcaemia. and axis deviation either due to left or right atrial enlargement.

Table 3: Summary of studies evaluating cardiovascular disease in patients with CKD

Author	**Study design**	**Sample size/the Age range of study population**	**Cardiovascular assessment**	**% with cardiovascular disease and presence of cardiovascular risk factors.**
Mitsnefes MM et al. (2020) (Egypt)	Retrospective study	64 (20mnths-22yrs)	Echocardiographic evaluation of left ventricular mass and geometry.	LVH- 48(75%) with 26(41%) having LVMI >51 g/m$^{2.7}$ Abormal LV geometry 64(80%), eccentric hypertrophy 25(39%),concentric LVH 23(36%). longer duration of illness before initiation of RRT (*P*=0.003) were risk factors for severe LVH. Higher systolic blood pressure (*P*=0.065) was an independent LVH predictor.
Adiele et al (2014) [Nigeria]	Cross- sectional study	24 (6-17 years)	Echocardiographic evaluation of the LV mass and geometry and LV systolic function.	LVH seen in 12(50%), concentric hypertrophy 4(16.7%), eccentric hypertrophy 8(33.3%), LV systolic dysfunction 2(8.3%), Valvular thickening (mitral, tricuspid, aortic) was each of equal prevalence at 3(12.5%) respectively. Hypertension and fluid overload were major risk factors of the cardiac abnormalities seen.
Chavers et. Al.	Cross-sectional study	656 (0.7-18 years)	Analysis of echocarcardiogram results from a database.	LVH/LVE common cardiac diagnoses (17%). Cardiac disease 24% (n=155), frequently diagnosed in patients with hypertension (29% vs. 14%(P < 0.0001), and longer duration of RRT (≥3yrs) was noted in those with cardiac disease.
Peter ID et. Al. 2018 (Nigeria)	Cross-sectional comparative study	21	Echocardiographic assessment of Elevated Mean Pulmonary Artery Pressure and Right Ventricular Dysfunction.	Prevalence of the right ventricle dysfunction in CKD patients was 9.5% and 0% in controls (P = 0.49). RVD was more common in the CKD (P<0.001) patients who had elevated mPAP and who had not received RRT.

Table 4: Summary of studies evaluating the role of modifiable risk factors of cardiovascular disease in CKD.

Article/Author	**Study design**	**Sample size/age range of study population**	**% with cardiovascular risk factors.**
Prevalence and Correlates of Multiple Cardiovascular Risk Factors in Children with Chronic Kidney Disease Wilson et al. (2011)	cross- sectional (data based)study	586 (1-16 years)	Hypertension(46%),dyslipidemia(44%) obesity (15%), and 21% had abnormal glucose metabolism, 39%, 22%, and 13% had one, two, and three or more respectively.
What has changed in the prevalence of hypertension in dialyzed children in the last decade? M. Tkaczyk et.al. (2017)	Cross-sectional study with a comparative arm of data collected 10 years earlier in CKD patients undergoing dialysis.	Two cohorts 59 children in 2013 compared to 134 children in 2003	Prevalence of hypertension increased from 64% (2003) to 78% (2013). Only 61% achieved proper BP control in 2013. Conclusion, there was an increased hypertension awareness in CKD as a risk factor to developing cardiovascular disease but found under-treatment of the condition a decade later thus increased morbidity.
Diagnosis of cardiac disease in pediatric end-stage renal disease. B. Chavers et. al. (2011)	cross-sectional data analysis study	656 (0.7-18 years)	Cardiovascular risk factors were in 92% of the patients, with hypertension being high at (63%),

2.5 Study justification and utility.

Cardiac dysfunction in CKD patients begins early in the disease and increases risk of premature death in children with CKD.

Children on follow-up for CKD in Kenyatta National hospital do not routinely receive an assessment of cardiac disease as the disease progresses.

This study assessed the burden of cardiac dysfunction in paediatric CKD patients to provide a baseline, raise awareness amongst health workers and inform local guidelines formulation.

2.6 Research question.

What is the prevalence of ventricular cardiac dysfunction in paediatric patients aged 3months -18 years with chronic renal disease on follow-up at Kenyatta National hospital?

2.7. Objectives.

2.7.1. Primary objective.

To determine the prevalence of ventricular cardiac dysfunction as measured by ECHO and/or ECG among pediatric patients aged 3months -18 years with chronic kidney disease on follow-up at Kenyatta National Hospital

2.7.2. Specific objectives.

Describe echocardiographic abnormalities among paediatric patients age 3months -18 years with chronic kidney disease at Kenyatta National Hospital.

Describe electrocardiographic abnormalities among paediatric patients aged 3months-18 years with chronic kidney disease at Kenyatta National Hospital.

Secondary Objective

To determine factors associated with ventricular systolic dysfunction in patients with CKD (factors of interest include duration of illness, renal replacement therapy and hypertension).

3.0. METHODOLOGY.

3.1. Study design.

A hospital-based cross-sectional study.

3.2. Study site.

The study was carried out in Kenyatta National Hospital (KNH). KNH is the main tertiary referral hospital in the country and the teaching hospital for the University of Nairobi, College of Health Sciences. KNH is situated in Nairobi County and has an inpatient capacity of 2000 and annual patient turnover of approximately 600,000 patients.

Paediatrics nephrology services are provided in the outpatient renal clinics, renal units and inpatient wards. The adult wards/clinic/renal unit are included as part of the study site as children beyond 13 years are admitted/attended at the adult units/ ward/ clinic in this KNH. Participants will be recruited from both the adult and paediatric renal units, wards, and outpatient renal clinics. These clinics/wards/renal units are run by paediatrics/ adult nephrologists, fellows, registrars, and specialized nephrology nurses.

The estimated patient flow in the wards is 1-2 CKD patients admitted in both the paediatrics and adult wards each week while the outpatient clinic receives 4-5 new CKD patients every week. This gives an estimate of 20-25 new CKD patients every month. There are also 30-40 CKD patients as per the hospital records. All existing and new patients will be recruited in the study.

3.3. Study period.

The study period was 7 months (March 2022-October 2022).

3.4. Study population.

Pediatric patients aged 3 months -18yrs with chronic renal disease on follow-up at Kenyatta National Hospital.

3.4.1. Inclusion criteria.

- Children aged 3months-18 years with CKD, receiving care at KNH with available records.
- Guardian gave consent and child assent if > 7 years

3.4.2. Exclusion criteria.

- Children aged < 3 months of age.
- Primary cardiac disease diagnosed before the diagnosis of CKD.
- Guardian Declined consent and assent if > 7 years.

3.5. Case definitions.

3.5.1. Ventricular systolic Cardiac dysfunction.

Echo Features:

Left ventricular hypertrophy:

LVMI above the 95th percentile for age, gender.

Left ventricular systolic dysfunction-

Ejection fraction <54%
Fractional shortening <28%

Right Ventricular Systolic dysfunction:

Tricuspid annular plane systolic excursion (TAPSE) - < 1.6cm adjusted for age, gender and BSA.

Fractional Area Change (%FAC) < 35%

Electrocardiographic features:

Corrected QT interval (QTc) >0.44sec,

QRS duration <3yrs > 70ms, 3-8 yrs> 80ms, 8-12 yrs> 90ms, >12 yrs> 100ms

Left Ventricular Hypertrophy (sV1+rV6/V5) > 35 mm

3.5.2. Chronic kidney disease.

GFR < 60 mL/min per 1.73 m^2 for greater >3 months

GFR > 60 mL/min per 1.73 m^2 structural damage or other markers of kidney function abnormalities e.g. proteinuria

In children below age 2 years, calculated GFR based on serum creatinine is compared with normative age-appropriate values to detect renal impairment

3.6. The Sample size.

Fisher's formula was used to determine the sample size, with a population correction factor. An estimated target population of 70 was used for the calculation based on the estimate of 20 to 25 patients seen every month. For the sample size calculation, the estimated prevalence was set at 50% as there is no similar study that has been done.

$$n = \frac{NZ^2 P (1-P)}{d^2 (N-1) + Z^2 P (1-P)}$$

- N= estimated target population = 70
- n= original estimated sample size from finite population= 60
- P= estimated prevalence of outcome of interest= 50%
- Z= level of confidence (1.96 for 95% CI)
- d= desired level of precision (0.075)
- Corrected sample size = 50 participants

From the above calculations, the sample size for the study was 50 participants.

3.7. Sampling method.

A total of 70 records of patients with a CKD diagnosis were retrieved from the KNH medical records. 40 of these files were excluded as they did not meet the inclusion criteria, 30 of the patients were contacted via phone and verbal consent obtained, 10 declined to take part in the study. Consecutive sampling was then done in the hospital renal units, clinic and wards and consent obtained from guardians and assent from those above 7 years of age until the desired sample size was attained.

3.8. Sampling procedure.

3.8.1. Diagnosis Procedure

Pediatric patients who fit the inclusion criteria and a diagnosis of CKD at KNH has been made, were identified by going through their hospital records.

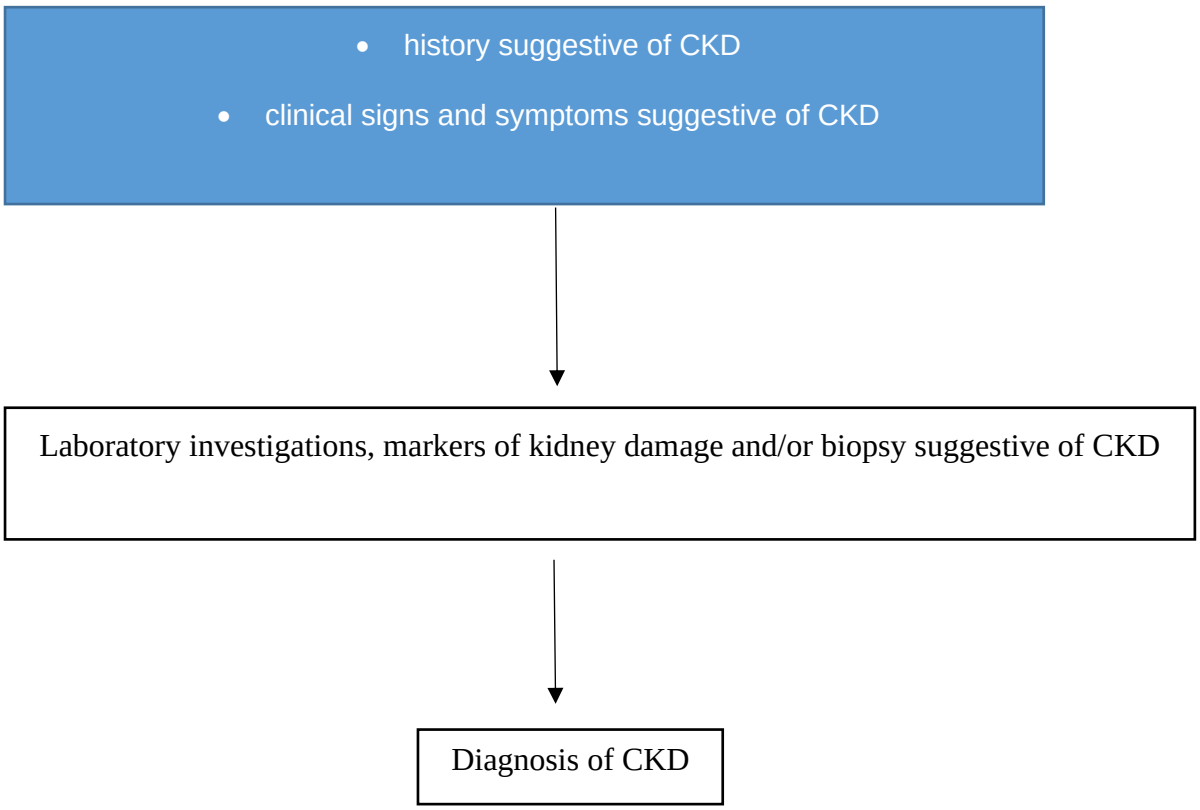

Figure 1: Showing diagnosis of CKD at Kenyatta National Hospital.

3.8.2 Screening and recruitment procedure

Patients with chronic kidney disease who meet the inclusion criteria were identified from the medical records department at Kenyatta National Hospital and invited to participate in the study through mobile phone communication. Patients/parents were then informed of the study and verbal consent was obtained. Participants who consent verbally on phone were asked to come to the study site where written consent from caregivers of eligible patients and assent where appropriate was obtained. A study registration number was then issued and noted by the study assistant in a study register book that was kept separate from the data collection forms. This was done to avoid double registration of patients during subsequent visits and to also assign each study participant a unique identification number.

3.9. Patient flow.

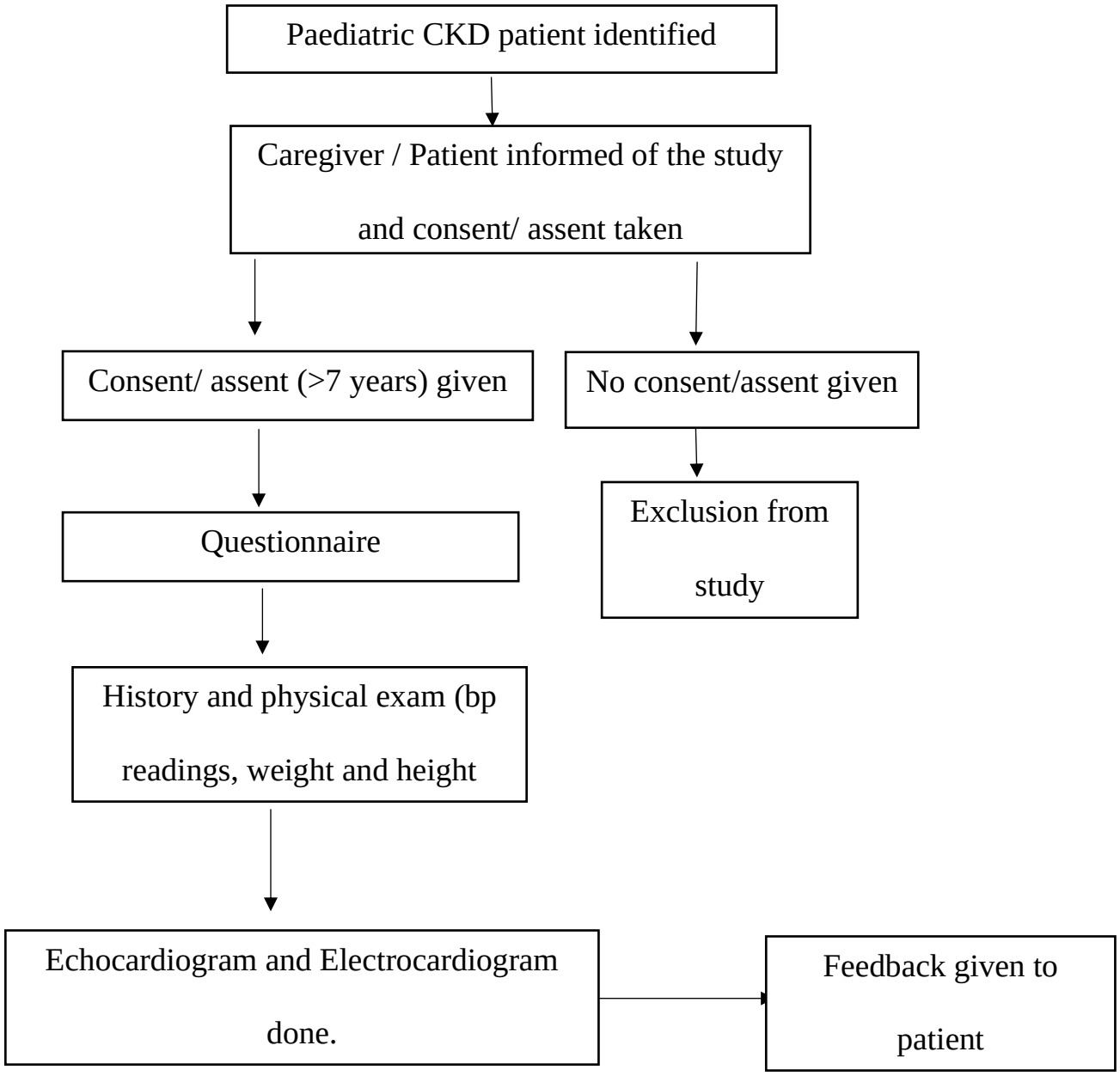

Figure 2: showing patient flow, selection, and recruitment during the study

3.10. Data collection.

Data was collected by the principal investigator and the research assistant. Research assistant was hired with an aim to aid the principal investigator with data collection. Research assistant was a registered clinical officer and was working/ studying within the hospital and therefore he/she was familiar with the day-to-day running of the hospital. The research assistant was trained and supervised on how to administer the questionnaire.

3.11. Clinical methods.

The data collection tool (questionnaire) was used to collect data from the patients. The questionnaire captured data on age, gender, date of diagnosis, duration of illness, level of education and place of residence. Details on the treatment the patient was receiving and whether or not the patient was on renal replacement therapy was recorded.

Three consecutive blood pressure readings 30 seconds apart were taken for each patient using a digital blood pressure machine and an appropriate cuff size was used. Elevated blood pressure was defined as (systolic BP or diastolic BP above the 95th percentile for age, height, sex).

Anthropometric measures were taken where height and weight were used to calculate the Body surface area.

Transthoracic Echocardiogram (TTE) was done to determine Left Ventricular Hypertrophy by measuring the LVMI; Left ventricular systolic Dysfunction by measuring the Ejection fraction and fraction shortening), Right Ventricular systolic dysfunction by measuring the tricuspid annular plane systolic excursion. (TAPSE) and percent fractional area change). valvular calcification and valvular regurgitation were also recorded.

Electrocardiogram (ECG) was done QTc, QRS interval, left ventricular hypertrophy and cardiac axis were assessed.

2D-Echo was done by an experienced sonographer and reviewed, reported by a Paediatric Cardiologist. ECG was done and reviewed, reported in the presence of a Paediatric Cardiologist.

3.12. Quality control

The echo machine used had been regularly serviced and results produced were reviewed by a qualified paediatric cardiologist. ECG quality control, the ECG machine used had been regularly serviced and results produced were reviewed by a qualified paediatric cardiologist.

3.13. Data storage and security.

Each questionnaire, echo, and ECG results was checked to ensure that there were no personal identifiers to maintain the confidentiality of the patients. Any personal identifier found was discarded. The principal investigator was responsible for the storage of all questionnaires, echo, and ECG results and these were only accessible to the principal investigator. These measures ensured that patient confidentiality was maintained at all times. The study patient register linking the patient medical records number and the patient study number were kept by the principal investigator under lock and key.

3.14. Data management and analysis.

The collected study data was entered into a customized password-protected MS Access database. After completion of data entry, the data was exported to STATA (version 15) software for cleaning, verification, and analysis. Data analysis involved describing the study's participants' characteristics. This included gender, age, duration of illness on follow-up, hypertensive state and if on medication, these analyses were presented as medians and means for the continuous variables and as frequency tables or graphs for categorical variables.

3.14.1. To determine the prevalence of ventricular systolic cardiac dysfunction among patients:

The ventricular systolic cardiac dysfunction was presented as a proportion. The proportions of the various categories of cardiac dysfunction found i.e. left and right ventricular systolic dysfunction and left ventricular hypertrophy were presented in tables.

3.14.2. Factors associated with cardiac dysfunction

The factors associated with ventricular systolic cardiac dysfunction in paediatric CKD (Hypertension, duration of illness and renal replacement therapy) was analysed using bivariate tests of association. *P-values* for categorical variables, t-tests for continuous variables. A logistic regression model was used

to model for the binary dependent variable. The adjusted odds ratio was used to compare the relative odds of the significant predictor variable and the binary outcome variable.

3.14.3. Data on treatment modalities.

This information was taken verbally from the patients and also from the patient's medical file and filled in the data collection tool and was presented as a proportion and results are presented in tables.

3.15. Ethical considerations.

Ethical approval was sought from the KNH/UON research and ethics board (Appendix 8). Authorization to conduct the study was sought from KNH administration.

Patient confidentiality was maintained and a study number assigned and patient identifying data avoided. The study patient register linking the patient medical records number and the patient study number were kept by the principal investigator under lock and key separate from the rest of the data collected.

Only Patients who fulfilled the inclusion criteria were included in the study after consent/ assent was given. The aim of the study was communicated to the participant in a language they understood to ensure an informed consent/ assent was obtained. Consent/ Assent was given on written forms which were predesigned. For those aged below 7 years, parents signed the consent form. For those aged 7 and below the age of 18, an assent form was signed upon agreeing to participate in the study and a consent form which was also filled by the parent / guardian.

Giving of consent/assent was free of coercion and non-consenting parents were assured of continued best clinical practice and non-discrimination. There was no financial implication transferred to the patient who gave consent/assent to participate in the study.

3.16. Control of Biases and Errors

The following measures were undertaken to reduce occurrence of bias and errors.

- Standard case record form was used on every study participant to ensure uniformity and standardization.
- The principal investigator ensured validity of collected data and accurate transcription of the ECHO and ECG results by using a crosschecking method.

- Study participants were identified by a unique study identification number and did not have their names or contacts entered onto the questionnaire to maintain confidentiality.
- Questionnaires were assessed for completeness at the time of collection. Data was then entered into a secure computer.

3.17. Dissemination of study findings.

Study findings will be disseminated to the relevant authority at KNH as well as presentation of findings as part of the thesis defence to the Department of Paediatrics, University of Nairobi in both hard and soft copies. The study results will be provided to the hospital to aid in the development of a protocol for the management of all paediatric CKD patients. Echo and ECG results obtained in the study were communicated directly to the attending physician and the patients within 72 hours. Patients also received a hard copy of the results.

4.0 RESULTS

We screened 70 files that were obtained from the KNH medical records. At screening, 40 of the patients' files were not eligible due to loss of follow up and demise of the patients (n=30). This left 30 eligible subjects from the file records. All 30 were contacted via phone 10 of this declined to participate in the study (n=20). The remaining 20 were then given a date on when they would come in and sign a physical consent form and participate in the study. The other patients were consecutively sampled from the paediatric and adult renal units, clinics and wards (n=29). We obtained consent from 49 participants and enrolled them into the study (as shown in figure 3 below). Clinical assessment, blood pressure and anthropometric measures was taken for all 49 patients and ECG and ECHO done.

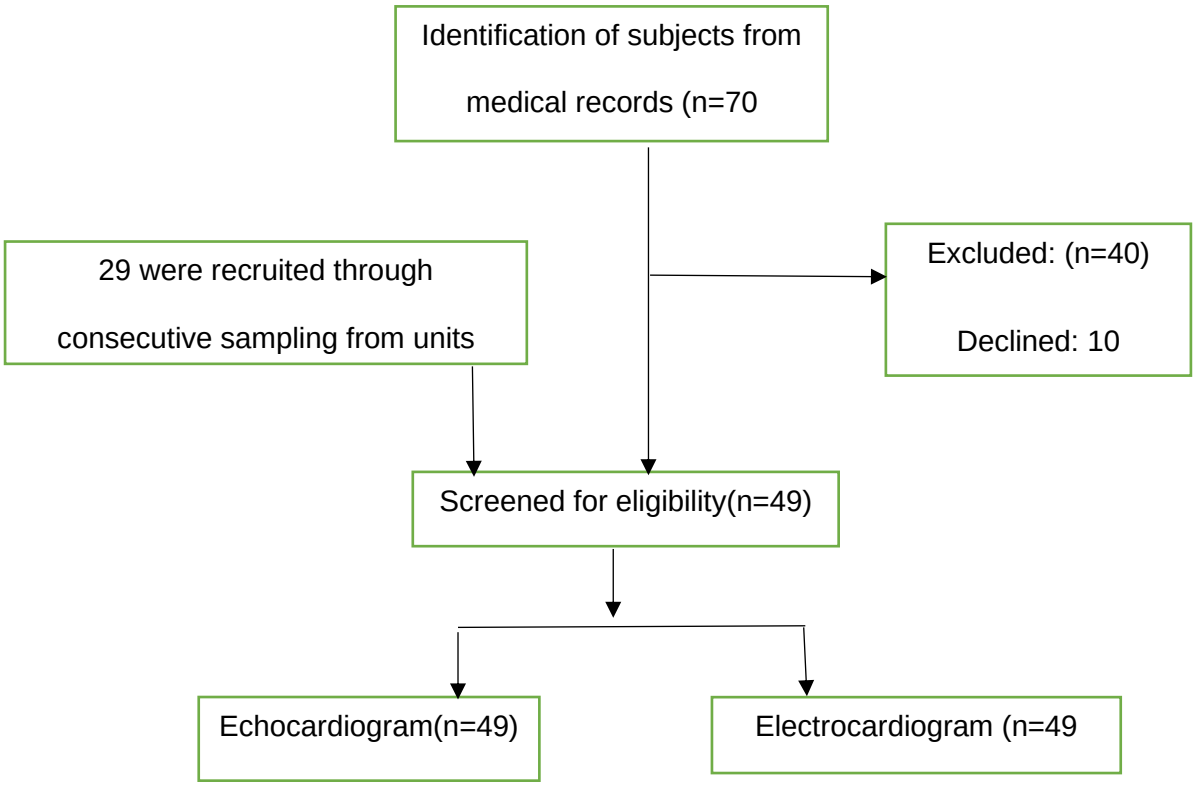

Figure 3: study screening and enrolment procedure.

4.1 Socio-demographic Characteristics of the Study Participants

There were 49 children enrolled into the study, the age ranged from 7-216 months, a median age of 132 months (IQR 72,192) as shown in Table 5. Majority of the children were aged between 12-18 years (40.82%). The male to female ratio was 1.3:1. A third 16 (32.65%) of the children had not yet enrolled into school, 20 (40.82%) were in primary and 13 (26.53%) were secondary school students. The majority of the children 22 (44.90%) were residents on Nairobi where the Kenyatta National Hospital is domiciled, 11 (22.45%) were from neighbouring counties and remaining spread around the country. A total of 46 (87.76%) had a diagnosis of CKD made at the Kenyatta National hospital while 6 (12.2%) were referrals.

Table 5: Socio-demographic characteristics of the study participants

Variable	N=49	%
Age in months **Mean (min,max)** **Median (IQR)**	 Mean=125.49 132	 Min,max-7,126 IQR-72,192
Age: **Under 5 Years** **6-12 Years** **Over 12 Years**	 12 17 20	 24.49 34.69 40.82
Male	28	57.14
Female	21	42.86
Male to female ratio	1.3:1	
Level of education attained:		
None	16	32.65
primary	20	40.82
secondary	13	26.53
Current residence		
Nairobi	22	44.90
Kiambu	9	18.37
Muranga and Nakuru (3 each)	6	12.24(6.12%each)
Machakos	2	4.08
Others*	10	20.4
Time since diagnosis		
0 (Diagnosed in 2022)	17	34.69
1 Year (Diagnosed 2021)	8	16.33
2 Years (Diagnosed 2020)	6	12.24
3Years (Diagnosed 2019)	4	8.16
4 Years (Diagnosed 2018)	6	12.24
5+ Years (Diagnosed 2017 and below)	8	16.33
Hospital where diagnosis was made:		
Kenyatta National Hospital	43	87.76

Aga-Khan (Laikipia), Isiolo, Machakos, Mathari (Nyeri), Mbagathi, and Nakuru (One Each)	6	12.24 (2.04% each)

* Embu, Garissa, Isiolo, Kajiado, Kitui, Laikipia, Meru, Mombasa, Nyeri and Samburu (one each)

Figure 4 shows that 17 (34.7%) of the children were diagnosed with CKD in the year of study, 8(16.33%) the prior year, 6 (12.24%) 2 years ago, 4 (8.16%) three years prior to the study and 6 (12.24%) four years preceding the study. Eight (16.33%) children had been on follow-up for 5 or more years. In other words, just over 80% of the children with CKD had been in care for $\leq$ 4 years.

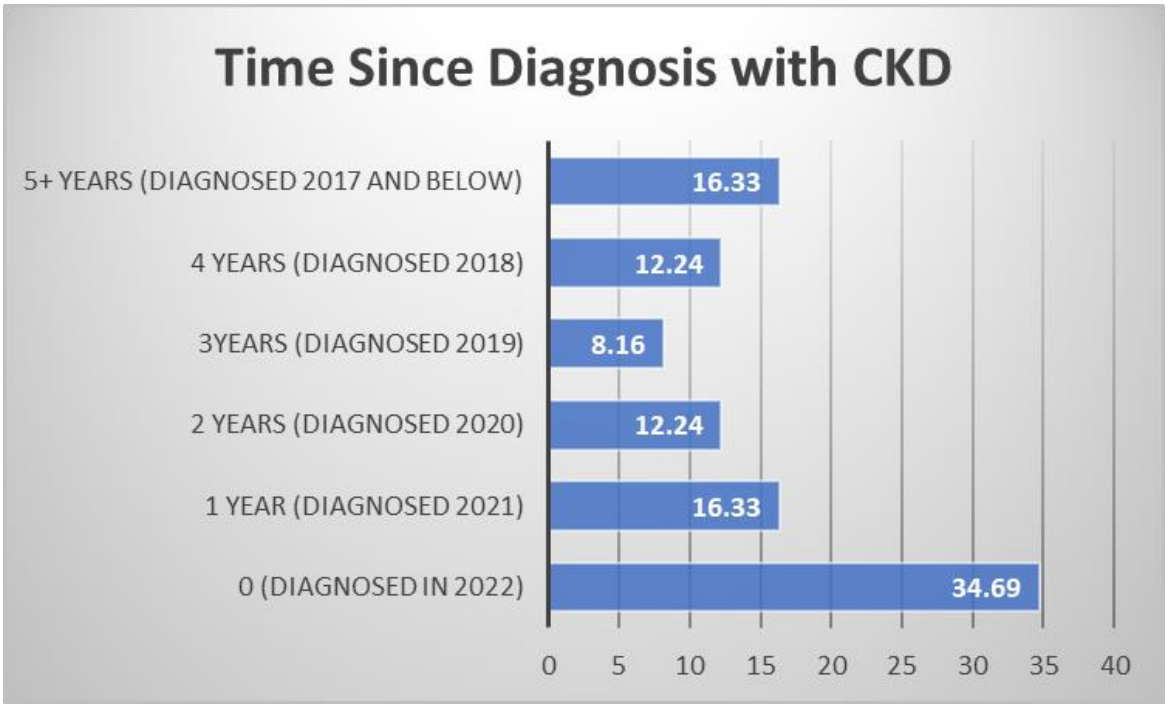

Figure 4: Time Since Diagnosis with CKD

4.2 Clinical Characteristics of the study participants

Table 6 shows the clinical characteristics of the patients. They had heights between 65 and 178 centimetres (Median=144cm) and weighed between 5 and 65 Kilograms (Median 30Kgs). The children's BMI was between 8.05 and 25.48, this together with the Z score the study found 12 (24.5%) were wasted, 2 (4.08%) overweight and 1 (2.04%) obese. Thirty one (67.4%) children had a normal BMI. It was noted that over 70% of the patients had elevated blood pressure (36, 73.47%) despite 39(81.25%) being on antihypertensive treatment. Twenty eight (58.3%) were noted to be on steroids. A total of 16 (32.65%) were on renal replacement therapy with a majority of this 12 (75%) being on haemodialysis and 4(25%) on peritoneal dialysis. Of the 16 patients on renal replacement therapy 10

(62.5%) had been on dialysis for less than one year while only 1 (6.25%) had received dialysis for more than 3 years.

Table 6: Clinical characteristics of study participants

Weight Kg: mean, median, IQR	Mean =30.22 (s.d) = 15.2 Min, Max= (5,65)	Median = 30.00kg IQR= (18,42) =24
Height (cms) mean, median, IQR	Mean = 132.4 s.d =30.12 Min, Max= 65,178	Median=144 IQR= 108,154=46
BMI: mean, median, IQR	Mean=16.13 s.d= 3.40 Min, Max=8.05, 25.48	Median= 16.0229 IQR=14.47,17.48
Categories based on WHO Z-Score Wasted	 12	 24.5%
Normal	31	67.4%
overweight	2	4.08%
Obese	1	2.94%
W/H Z Score:	Mean= -2.05 s.d= 4.6 Min, Max= (-25.05, 2.39)	Median=-1.14 IQR= (-2.23,0.01)
Blood Pressure Elevated	 36	 73.47%
Access to diagnostic services	n	%
Dialysis		
Patient Ever Been on Dialysis Haemodialysis Peritoneal dialysis	**16** 12 4	**32.65** 75 25
Patient on dialysis currently	16	32.65
Date since Dialysis start 0 Years (Started in 2022) 1 Year (Started in 2021) 2 Years (Started in 2020) 4 Years (Started in 2018)	 10 3 2 1	 62.50 18.75 12.50 6.25
Assess to essential medication		
Antihypertensive	39	81.25
Steroids	28	58.33
Others	22	62.86

4.3 Prevalence of Ventricular cardiac dysfunction on ECHO and /or ECG

Ventricular cardiac dysfunction was found in 44(89.8% (95%CI 77.1,95.8)) children as seen in Table 7 below. This was seen derived from abnormalities seen on both ECHO and/or ECG. A total of 42(87.71%) had left ventricular hypertrophy and ventricular systolic dysfunction on echo while only 15 (30.61) had abnormalities seen on ECG.

Table 7. Prevalence of Ventricular cardiac dysfunction in patients with CKD.

Ventricular Cardiac Dysfunction	No. of children n=49	95%CI
Echocardiography and /or ECG	44 (89.8%)	77.1,95.8
Echocardiography	42 (87.71%)	72.3,93.2
Electrocardiography	15 (30.61%)	19.0,45.3

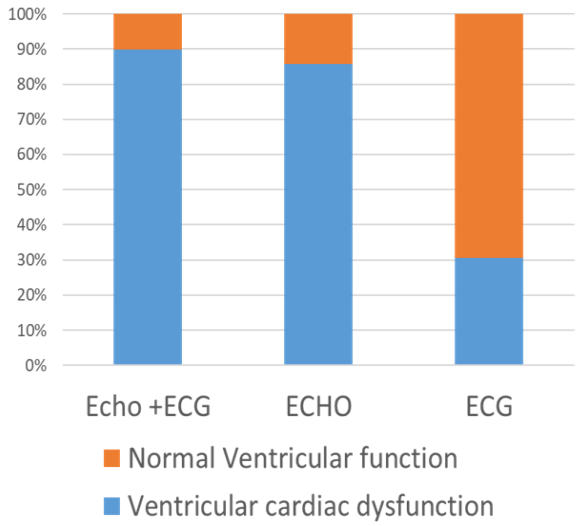

Figure 5: prevalence of ventricular cardiac dysfunction

4.4 Echocardiographic abnormalities of children with CKD.

Ventricular cardiac dysfunction was further looked at in detail as shown in Table 8 below. The echocardiographic characteristics that were described to get the prevalence of ventricular cardiac dysfunction were the left ventricular hypertrophy where LVMI > 95th percentile for age, gender and

BSA was used. This was calculated from the left ventricular mass that was measured on echo and indexed to height. Thirty eight (77.5%) children were found to have left ventricular hypertrophy. A total of 23 (46.94%) patients had Left ventricular systolic dysfunction as summarized in table 9. Majority of these had right ventricular systolic dysfunction at 12(52.17%) while only 6(26.08%) had left ventricular systolic dysfunction. A small number 5 had both right and left ventricular systolic dysfunction. An abnormal ejection fraction was seen in 11 (22.45%) while 9 had an abnormal fractional shortening 9 (18.37%). TAPSE was measured for right ventricular systolic dysfunction and 7(14.29%) were found to have an abnormal TAPSE while 14(28.57%) were found to have abnormal fractional area change.

It was noted that 31 (63.27) of the children had valvular calcification with aortic calcification being the highest number at 23(46.94%). Valvular regurgitation was also noted in 36 (73.47%) of the children studied. Six(12.24%) were also noted to have pericardial effusion. Only 5 (10.20%) were noted to have poor ventricular wall mobility. This parameter were incidental findings and were not used in the calculation of the prevalence of ventricular systolic cardiac dysfunction.

Table 8: Echocardiogram features in children with CKD

	n=49	% (95%CI)
Left ventricular hypertrophy	38	77.55% (63.3,87.3)
LVM	Min, Max= (10.31,325.43) g Mean= 130.384	Median=115.4g s.d=77.46
Ejection fraction Abnormal Ejection Fraction	Min, Max= (24%,77%) 11	Median=67% 22.45%
Fractional shortening Abnormal Shortening Fraction	Min, Max =(11%,48%) 9	Median= 36% 18.37%
TAPSE Abnormal	Min, Max= (1.4,3.9) 7	Median=2.4 14.29%
Fractional Area Change (%FAC) Abnormal	Min, Max= (20%, 95.7%) 14	Median=40.6% 28.57%
Valvular Calcification-Yes Aortic Aortic and Pulmonary Pulmonary	31 23 6 2	63.27% 46.94% 12.24% 4.08%
Valvular Regurgitation-Yes	36	73.47%
Pericardial Effusion- Yes	6	12.24%
Ventricular wall mobility	5	10.20%

Table 9: Summary of Ventricular systolic dysfunction

Ventricular Systolic dysfunction	23 (n=49)	46.94% (95% CI -33,61.2)
Left ventricular systolic dysfunction (only)	(n=23) 11 (6)	22.45%(26.08%)
Right ventricular systolic dysfunction (only)	17 (12)	34.69% (52.17%)
Both right and left ventricular systolic dysfunction	5	21.74%

4.5 Electrocardiographic abnormalities of patients with CKD

Table 10 below shows the summary of electrocardiogram characteristics of the study patients. The QRS readings were within the normal range for all children. The QRS readings had a mean of 72.09 (median=70) with a range of 56 to 130ms (Normal after adjusting for age). The QTC had a range from 0.37sec to 0.46sec., the study found that 13 had abnormal QTC readings >0.44sec (26.53%).

Only 4.08% had axis deviation (2 Left axis Deviations). Unlike the results from the echocardiogram the results showed that on 8.16% of the children had Left Ventricular Hypertrophy. Only one study participant had an elevated ST Segment, while none of the children had irregular sinus rhythm.

Table 10: Electrocardiogram features in children with CKD

	N=49	
QRS	Min, Max=(56,130) Median= 70	Mean= 72.093 s.d=12.60
QTC Abnormal	Min, Max= (370,469) 13	Median= 409 26.53%
Axis Deviation- (Left)	2	4.08%
Left Ventricular Hypertrophy	4	8.16%
ST Segment on ECG- Elevated	1	2.04%
Abnormal Sinus Rhythm	0	0.00%

4.6 Association between ventricular systolic dysfunction duration of illness, hypertension and renal replacement therapy.

Table 11 shows the output of test of association between Ventricular systolic dysfunction and some of the variables from our study. There was no significant association between ventricular systolic

dysfunction and our variables but the duration of illness and age groups both had a p-value less than 0.2 that is (0.197 and 0.124 for age groups and Duration of illness respectively. The remaining variables had p-values more than 0.5 which meant that their association with VSD could not be determined from our sample size.

We further went ahead and did logistic regression with our chosen variables. From the odds ratios and confidence intervals we found that none of the variables were statistically significant. Those children who have had chronic kidney disease for more than three years were almost three times likely to develop ventricular systolic disorder (OR=2.7, CI=0.75,9.76) when compared to those children who have had the disease for three years or less. Children who were under five during our study were 14.5% more likely to develop Ventricular Systolic Disorder (VSD) when compared to children who were aged 13-18 years (OR=1.145, CI=0.27,4.87). When comparing children aged 6-12 and 13-18 years there was no discernable age group more likely to develop VSD (OR=0.341, CI=0.09,1.34).

Female gender and Hypertension were potential risk factors for developing ventricular systolic Dysfunction, where children of the female gender were 47% more likely to develop VSD when compared to their male counterparts (OR=1.47, CI=0.47,4.57). This is evident as only 42.86% of the male children had VSD while 52.88% of the female children had VSD. On the other hand, children with elevated high pressure were only 4% more likely to develop VSD as compared to those children with no hypertension. This is proven as the percentage of children with VSD was 47.22% vs 46.15% when comparing those with hypertension and those without respectively.

Children on renal replacement therapy were not on risk of getting ventricular systolic dysfunction. (OR=0.83, CI=0.25,2.73). The percentage of children on renal replacement therapy with VSD was only 43.75% which is less when compared to the percentage of children who were not on renal replacement therapy with VSD (48.48%).

Table 11: Multivariable Logistic Regression for association of ventricular systolic dysfunction and duration of ill, hypertension and renal replacement therapy

Category	Normal Ventricular function N=26	Ventricular SD N=23	Unadjusted OR (95% Confidence interval)	Adjusted OR	P-Value
Age Group					
Under 5	5(41.67%)	7(58.3%)	1.15(0.3,4.9)	1.59(0.3, 7.9)	0.2
6-12 Years	12(70.59%	5(29.4%)	0.34(0.1,1.3)	0.40(0.1-1.7)	
13-18 Years	9(45%)	11(55%)	Ref	Ref	

Gender					
Male	16(57.1%)	12(42.9%)	Ref	Ref	0.5
Female	10(47.6%)	11(52.9%)	1.47(0.5,4.6)	1.13(0.3,4.2)	
CKD Duration					
<3 years	21 (60%)	14 (40%)	Ref	Ref	0.1
>3 years	5 (35.7%)	9(64.3%)	2.7(0.8,9.8)	3.14(0.7,13.3)	
Hypertension					
Yes	19(52.8%)	17(47.2 %)	1.04(0.3,3.7)	1.25(0.3,5.8)	0.9
No	7(53.9%)	6(46.2%)	Ref	Ref	
Renal RT					
Yes	9(56.3%)	7(43.8%)	0.83(0.3-2.8)	0.84(0.2,3.0)	0.8
No	17(51.5%)	16(48.5%)	Ref	Ref	

5.0 DISCUSSION

The main aim of this study was to determine the prevalence of ventricular cardiac dysfunction in paediatric patients aged 3 months-18 years with chronic renal disease on follow-up at Kenyatta National hospital. Further, the study evaluated echocardiographic abnormalities plus electrocardiographic abnormalities among paediatric patients aged 3months – 18 years with chronic kidney disease at Kenyatta National Hospital. Also, the researcher determined factors associated with ventricular systolic dysfunction in patients with CKD (factors of interest include duration of illness, renal replacement therapy and hypertension).

After analysing all the echocardiogram and ECG results we found that 44 (89.8% (95%C1 77.1,95.8)) of the children had some form of ventricular cardiac dysfunction. Our findings are in line with a study conducted at the University of Nigeria teaching hospital by Adiele et al where 24 paediatric patients with CKD aged 6-17 years were studied using echocardiogram as a tool and 22 (91.7%) of these were found to have cardiac abnormalities.(22) The most common abnormality was found to be left ventricular hypertrophy. In another study Mitsenefes et al conducted a retrospective study on 64 patients (20 months to 22 years) and found that 75% of the children had LVH This is similar to the findings in our study where 33(78%) of our CKD patients were diagnosed with ventricular hypertrophy. Adiele et al found that most of the patients had eccentric hypertrophy while we noted that all the children we studied had concentric hypertrophy. The increase in the left ventricular mass in most of these children may be attributable to the fact that most of them were found to be hypertensive 36(73%) despite being on blood pressure medication. Diagnosis of LVH on ECG was not significant. Only 4 (8.16%) children were found to have LVH on ECG in our study, this is similar to a study done by Chavers et al on children (0.7-18 years) who were on dialysis, LVH was diagnosed in 77% using

echo and in 15% of the children using ECG. (13) thus ECG is not a sensitive diagnostic tool for structural cardiac abnormalities.

Out of the 49 children 23 were found to have ventricular systolic dysfunction (46.9%) (95%CI 33.1,61.3). Left ventricular systolic dysfunction was assessed by measuring the ejection fraction and/or the fractional shortening. Eleven (23%)children were noted to have left ventricular systolic dysfunction with a poor ejection fraction being noted in all 23% of this. Nine (18%) had both poor ejection fraction less than 54% and fractional shortening. We found that right ventricular dysfunction was more common in our set up. Abnormal % FAC was seen in 14(28.6) of children studied while abnormal TAPSE was seen in 7 (14.3%). There is a paucity of data on use of %FAC as a measure of right ventricular systolic dysfunction. Percentage fractional area change is highly user dependent and there is a great inter-observer variability(20) and thus may be the reason for such a high outcome in our results. TAPSE however has been studied in paediatric CKD patients. In a study carried out in Nigeria among 21 paediatric patients with CKD right ventricular dysfunction was found in 10% of the patients using TAPSE which is similar to our findings(15). In our study right ventricular dysfunction was found to be higher than left ventricular dysfunction35% and 23% respectively.

After adjusting for age, only 13(26.53%) children had abnormal QTC readings. Only 4.08% had axis deviation, 8.16% of the children had Left Ventricular Hypertrophy and only one study participant had an elevated ST Segment, while none of the children had irregular sinus rhythm. In a study done in Saudi Arabia they found that 50% of children had Prolonged QT interval which may progress to ventricular fibrillation resulting in sudden death (24). The study however was done on patients with ESRD just before their renal replacement therapy sessions. These and other ECG changes in their study patients may have been from electrolyte imbalances in patients with ESRD. However, in our study, many patients were not in ESRD or they were on RRT and this may explain the difference in our findings on ECG changes.

There was no significant association between ventricular systolic dysfunction and our independent variables. No significant association was found with duration of illness and developing ventricular systolic dysfunction p-value 0.124. This finding may be due to the small sample size that was used in the study. Previous studies have shown that there is a direct association between the duration of illness and the development of cardiac dysfunction in CKD patients. Chavers et al found Cardiac disease 24% (n=155), was more frequently diagnosed in the patients with hypertension (29% vs. 14% ($P < 0.0001$). Our study did not produce a significant p-value while associating hypertension and ventricular systolic

dysfunction this may be due to the study being underpowered and also other factors may be associated with development of ventricular systolic dysfunction other than the hypertension.

We also found that 73% of the children were hypertensive despite being on antihypertensive medication. 39(81%) of them were found to be on antihypertensives but there was poor control of the blood pressure. This is a cardiovascular risk factor in development of LVH. Wilson et al conducted a study looking at the cross-sectional data of the first follow up visits during the CKiD study, they found that of 250 participants, 46%(n=115) were hypertensive, thus showing that at least half of the paediatric patients with CKD have cardiovascular risk factors early in the disease and this may be well before they progress to ESRD. Similarly, most of the patients we studied were still in the early stages of the disease and were noted to be hypertensive.

Other significant findings that were noted on Echo in our CKD patients was that 31(63%) had valvular calcification. Aortic calcification was the most prevalent at 47%. Valvular regurgitation was also noted in these patients at 73% with most having mild tricuspid regurgitation.

5.1 Strengths of the study

This was the first study to provide insight into the problem of ventricular cardiac dysfunction amongst children with chronic kidney disease in Kenya.

It was able to highlight other cardiac problems that are found on echo in patients with CKD like valvular calcification and regurgitation.

It gave information on the poor control of hypertension in our CKD patients despite most of them being on hypertensive medication and has shown the importance of involvement of multidisciplinary team in the management of this patients.

5.2 Study Limitations.

- Small study population size thus the study was underpowered.
- The results of the study are not generalizable as this was a tertiary hospital based study.

5.3 Conclusion

Children with CKD on follow up at KNH have a high prevalence of ventricular cardiac dysfunction at 90%. Left ventricular hypertrophy was found to be high (78%) in our patients with CKD. Right ventricular systolic dysfunction was higher than left ventricular systolic dysfunction in these patients.

Most of the patients studied were found to be hypertensive (73.5%) despite most of them (81%) being on blood pressure medication.

There was no association found with development of ventricular systolic dysfunction in patients who were on dialysis, those with hypertension and also those with longer duration of illness this may be attributable to the small sample size.

5.4 Recommendations

- All CKD patients should be on regular follow up with a cardiologist for better management of the cardiac disease.
- Regular ECHO should be done in patients with CKD so as to diagnose cardiac dysfunction early and monitor for progression of disease.
- Further studies can be done with a larger sample size to look for significant association between duration of illness, hypertension and renal replacement therapy.

BIBLIOGRAPHY

1. Naicker S. End-stage renal disease in sub-Saharan Africa. Ethn Dis. 2009 Spring;19(1 Suppl 1):S1-13-5.

2. Hill NR, Fatoba ST, Oke JL, Hirst JA, O'callaghan CA, Lasserson DS, et al. Global Prevalence of Chronic Kidney Disease-A Systematic Review and Meta-Analysis. PLoS One. 2016 Jul 6;11(7).

3. Hogg RJ, Furth S, Lemley K V, Portman R, Schwartz GJ, Coresh J, et al. National Kidney Foundation's Kidney Disease Outcomes Quality Initiative Clinical Practice Guidelines for Chronic Kidney Disease in Children and Adolescents: Evaluation, Classification, and Stratification.Pediatrics. 2003 Jun;111(6 Pt 1):1416-21.

4. Mitsnefes MM. Cardiovascular complications of pediatric chronic kidney disease [Internet]. Vol. 23, Pediatric Nephrology. Springer; 2008. p. 27–39.

5. Odetunde OI, Okafor HU, Uwaezuoke SN, Ezeonwu BU, Adiele KD, Ukoha OM. Chronic kidney disease in children as seen in a tertiary hospital in Enugu, South-East, Nigeria. Niger J Clin Pract. 2014 Mar;17(2):196–200.

6. Ardissino G, Daccò V, Testa S, Bonaudo R, Claris-Appiani A, Taioli E, et al. Epidemiology of Chronic Renal Failure in Children: Data From the ItalKid Project. Pediatrics. 2003 Apr;111(4 Pt 1):382-7.

7. Al-Eisa A, Naseef M, Al-Hamad N, Pinto R, Al-Shimeri N, Tahmaz M. Chronic renal failure in Kuwaiti children: An eight-year experience. Pediatr Nephrol. 2005 Dec 16 ;20(12):1781–5.

8. Al Riyami MS, Al Shehhi M, Al Sulaimi T, Al Mamary L, Al Maskari A, Al Ghaithi B, et al. Epidemiology and Outcome of CKD in Omani Children. Kidney Int Reports. 2019 May 1;4(5):727–32.

9. Abraham G, Varughese S, Thandavan T, Iyengar A, Fernando E, Naqvi SAJ, et al. Chronic kidney disease hotspots in developing countries in South Asia. Clin Kidney J. 2016 Feb 1;9(1):135–41.

10. Halle MP, Lapsap CT, Barla E, Fouda H, Djantio H, Moudze BK, et al. Epidemiology and outcomes of children with renal failure in the pediatric ward of a tertiary hospital in

Cameroon. BMC Pediatr. 2017 Dec 6;17(1):202.

11. Okafor U, Onwubere BJC, Odetunde OI, Uwaezuoke SN, Adiele DK, Okafor HU, et al. Echocardiographic Findings in Children with Chronic Kidney Disease as Seen in the Resource-Limited Setting. Niger J Clin Pract. 2014 Mar-Apr;17(2):196-200

12. Groothoff JW, Gruppen MP, Offringa M, Hutten J, Lilien MR, Van de Kar NJ, et al. Mortality and causes of death of end-stage renal disease in children: A dutch cohort study. Kidney Int. 2002 Feb 1;61(2):621–9.

13. Chavers BM, Solid CA, Sinaiko A, Daniels FX, Chen SC, Collins AJ, et al. Diagnosis of cardiac disease in pediatric end-stage renal disease. Nephrol Dial Transplant. 2011 May 1 ;26(5):1640–5.

14. Mitsnefes MM, Daniels SR, Schwartz SM, Meyer RA, Khoury P, Strife CF. Severe left ventricular hypertrophy in pediatric dialysis: Prevalence and predictors. Pediatr Nephrol. 2000 Sep;14(10–11):898–902.

15. Peter ID, Asani M, Aliyu I, Obiagwu P. Elevated mean pulmonary artery pressure and right ventricular dysfunction in children with chronic kidney disease. J Cardiovasc Echogr. 2018 Apr 1;28(2):109–13.

16. Peralta CA, Shlipak MG. Hypertension in children with chronic kidney disease: A call to action. Vol. 52, Hypertension. 2008. p. 610–2.

17. Tkaczyk M, Stańczyk M, Miklaszewska M, Zachwieja K, Wierciński R, Stankiewicz R, et al. What has changed in the prevalence of hypertension in dialyzed children during the last decade? Ren Fail. 2017 Nov 23;39(1):283–9.

18. Chinali M, Matteucci MC, Franceschini A, Doyon A, Pongiglione G, Rinelli G, et al. Advanced parameters of cardiac mechanics in children with CKD: The 4C study. Clin J Am Soc Nephrol. 2015 Aug 7;10(8):1357–63.

19. Chinali M, De Simone G, Matteucci MC, Picca S, Mastrostefano A, Anarat A, et al. Clinical Science Articles Reduced Systolic Myocardial Function in Children with Chronic Renal Insufficiency. J Am Soc Nephrol. 2007;18:593–8.

20. Koestenberger M, Ravekes W, Everett AD, Stueger HP, Heinzl B, Gamillscheg A, et al. Right Ventricular Function in Infants, Children and Adolescents: Reference Values of the Tricuspid Annular Plane Systolic Excursion (TAPSE) in 640 Healthy Patients and Calculation of z Score Values. J Am Soc Echocardiogr. 2009 Jun;22(6):715–9.

21. Mohamed Mohamed M, Abd Elhameed Ali R, Mohamed Mahmoud S. Electrocardiographic changes in chronic hemodialysis children at Sohag university hospital. J Am Sci. 2016 ;12(8):99–104.

22. Adiele D, Okafor U, Ojinnaka N, Onwubere B, Odetunde O, Uwaezuoke S. Echocardiographic Findings in Children with Chronic Kidney Disease as Seen in the Resource -Limited Setting. J Nephrol Ther. 2014;4(158):2161-0959.

APPENDICES

APPENDIX 1: DATA COLLECTION TOOL

CARDIAC DYSFUNCTION IN CHILDREN WITH CHRONIC KIDNEY DISEASE SEEN AT KENYATTA NATIONAL HOSPITAL

INSTRUCTIONS.

1. Complete the following questionnaire, providing as much information as possible.

2. Avoid giving any personal information.

3. Ask for assistance at any stage of this questionnaire.

PATIENT RECORD FORM :

CARDIAC DYSFUNCTION IN CHILDREN WITH CHRONIC KIDNEY DISEASE SEEN AT KENYATTA NATIONAL HOSPITAL

DATE: [ ][ ]/[ ][ ]/[ ][ ] **STUDY SERIAL NUMBER [ ][ ][ ]**

SOCIO-DEMOGRAPHIC DATA OF THE PATIENT

1. Age [ ][ ] months or [ ][ ] years

2. Sex: Male=1, Female=2 [ ]

3. Highest level of education attained: [ ]

Code: N/A=0, Primary=1, Secondary=2, Tertiary/College=3, University=4

4. Current residence:_____

5. Date or Year of diagnosis: [ ][ ]/[ ][ ]/[ ][ ]

6. Hospital where diagnosis was made:_____

7. Is patient on dialysis?: Yes=1, No=2 [ ]

8. Has patient ever been on dialysis?: Yes=1, No=2 [ ]

If yes indicate which dialysis: Hemodialysis=1 [ ] , Peritoneal dialysis=2 [ ]

9. Date of dialysis commencement: [ ][ ]/[ ][ ]/[ ][ ]

10. Date of termination (termination date only if temporary dialysis) [ ][ ]/[ ][ ]/[ ][ ]

11. Number of sessions per week: (when on regular dialysis) [ ]

12. Has the patient had an echocardiogram or electrocardiogram done before? Yes=1, No=2 [ ]

If yes, indicate when it was done: [ ][ ]/[ ][ ]/[ ][ ]

13. Current use of medication and duration

Name of medication	Date of commencement	Dose
<u>Antihypertensives</u> Yes=1, No=2 [ ]	[ ][ ]/[ ][ ]/[ ][ ] [ ][ ]/[ ][ ]/[ ][ ] [ ][ ]/[ ][	_____ _____ _____
<u>Steroids</u> Yes=1, No=2 [ ]	[ ][ ]/[ ][ ]/[ ][ ]	_____
Others Yes=1, No=2 (Specify)_____ **_____**	[ ][ ]/[ ][ ]/[ ][ ] _____ [ ][ ]/[ ][ ]/[ ][ ] _____	

14. PHYSICAL EXAMINATION

ANTHROPOMETRY
Weight: [ ][ ].[ ]
Height: [ ][ ].[ ]
BMI: [ ][ ][ ]
Z Score: _____
Blood pressure (Upper left arm): _____

15. ELECTROCARDIOGRAPHIC FINDINGS.

ECG INVESTIGATION	**FINDINGS**
QRS(ms)	_____
QTC(ms)	_____
AXIS (deviated)	_____
ST segment elevation	_____

20. ECHOCARDIOGRAPHIC FINDINGS

ECHO INVESTIGATION	FINDINGS
Left Ventricular hypertrophy Left Ventricular Mass Left ventricularMass Index Ejection Fraction Shortening Fraction Percentage fractional area change(%FAC) Tricuspid annular planar systolic excursion (TAPSE) Valvular calcification Valvular Regurgitation Pericardial Effusion	

Interviewer's name _____

Signature_____

APPENDIX 2: CONSENT FORMS

KNH-UoN/ERC/FORM/IC02

UNIVERSITY OF NAIROBI (UoN)

COLLEGE OF HEALTH SCIENCES

P O BOX 19676 Code 00202

Telegrams: varsity

(254-020) 2726300 Ext 44355

KNH-UoN ERC

Email: uonknh_erc@uonbi.ac.ke

Website: http://www.erc.uonbi.ac.ke

Facebook: ttps://www.facebook.com/uonknh.erc

Twitter: @UONKNH_ERC ttps://twitter.com/UONKNH_ERC

KENYATTA NATIONAL HOSPITAL (KNH)

P O BOX 20723 Code 00202

Tel: 726300-9

Fax: 725272

Telegrams: MEDSUP, Nairobi

PARENTAL CONSENT

Title of Study: PREVALENCE OF CARDIAC DYSFUNCTION AMONG PAEDIATRIC PATIENTS WITH CHRONIC KIDNEY DISEASE ON FOLLOW UP AT KENYATTA NATIONAL HOSPITAL.

Principal Investigator: DR. PRISCILLA WAIRIMU NGACHA

Introduction:

I would like to tell you about the above study being conducted by Dr. Priscilla Wairimu Ngacha. The purpose of this consent form is to give you the information you will need to help you decide whether or not your child should participate in the study. Feel free to ask any questions about the purpose of the research, what happens if your child participates in the study, the possible risks and benefits, the rights of your child as a volunteer, and anything else about the research or this form that is not clear. When we have answered all your questions to your satisfaction, you may decide if you want your child to be in the study or not. This process is called 'informed consent'. Once you understand and agree for your child to be in the study, I will request you to sign your name on this form. You should understand the general principles which apply to all participants in a medical research: i) Your child decision to participate is entirely voluntary ii) You child may withdraw from the study at any time without necessarily giving a reason for his/her withdrawal iii) Refusal to participate in the research will not affect the services your child is entitled to in this health facility or other facilities.

May I continue? **YES / NO**

For children below 18 years of age we give information about the study to parents or guardians. We will go over this information with you and you need to give permission in order for your child to participate in this study. We will give you a copy of this form for your records.

If the child is at an age that he/she can appreciate what is being done the he/she will also be required to agree to participate in the study after being fully informed).

WHAT IS THE PURPOSE OF THE STUDY?

Dr. Priscilla Ngacha is investigating children below the age of 18 years at Kenyatta National Hospital who have Chronic Kidney Disease. The purpose of the study is to find out the heart function in children with chronic kidney disease . Participants in this research study will be asked questions about the length of the illness and medications they are currentky taking and they will also undergo an electrocardiography and echocardiography test to look at the heart function. There will be approximately 60 participants in this study randomly chosen. We are asking for your consent to consider your child to participate in this study.

WHAT WILL HAPPEN IF YOU DECIDE YOU WANT YOUR CHILD TO BE IN THIS RESEARCH STUDY?

If you agree for your child to participate in this study, the following things will happen:

You will be interviewed by a trained interviewer in a private area where you feel comfortable answering questions. The interview will last approximately 40-45 minutes. The interview will cover topics such as the length of illness and the medication him/her is currently taking.

After the interview has finished, I will carry out an echocardiogram and electrocardiogram test on your child to assess the heart function. The results will enable me to know the current condition of his'/her heart.

We will ask for a telephone number where we can contact you if necessary. If you agree to provide your contact information, it will be used only by people working for this study and will never be shared with others. The reasons why we may need to contact you include to give you the results of your test.

ARE THERE ANY RISKS, HARMS, DISCOMFORTS ASSOCIATED WITH THIS STUDY

Medical research has the potential to introduce psychological, social, emotional and physical risks. Effort should always be put in place to minimize the risks. One potential risk of being in the study is loss of privacy. We will keep everything you tell us as confidential as possible. We will use a code number to identify your child in a password-protected computer database and will keep all of our paper records in a locked file cabinet. However, no system of protecting confidentiality can be absolutely secure so it is still possible that someone could find out your child was in this study and could find out information about your child.

Also, answering questions in the interview may be uncomfortable for you. If there are any questions you do not want to answer, you can skip them. You have the right to refuse the interview or any questions asked during the interview.

It may be embarrassing for you to have the electrocardiography and echocardiography test but we will do everything we can to ensure that this is done in private. Furthermore, all study staff and interviewers are professionals with special training in these examinations.

The tests being conducted are non- invasive and pose no risk to your child.

ARE THERE ANY BENEFITS BEING IN THIS STUDY?

Your child may benefit by receiving free evaluation of their heart function.

We will refer your child to a hospital for care and support if necessary. Also the information you provide will help us better understand the heart function in children with chronic kidney disease. This information is a major contribution to science.

WILL BEING IN THIS STUDY COST YOU ANYTHING?

The study will not cost you anything we will pay for the tests done.

IS THERE REIMBURSEMENT FOR PARTICIPATING IN THIS STUDY?

There will be no reimbursement cost for participating in this study.

WHAT IF YOU HAVE QUESTIONS IN FUTURE?

If you have further questions or concerns about your child participating in this study, please call or send a text message to the study staff at the number provided at the bottom of this page.

For more information about your child's rights as a research participant you may contact the Secretary/Chairperson, Kenyatta National Hospital-University of Nairobi Ethics and Research Committee Telephone No. 2726300 Ext. 44102 email uonknh_erc@uonbi.ac.ke.

The study staff will pay you back for your charges to these numbers if the call is for study-related communication.

WHAT ARE YOUR OTHER CHOICES?

Your decision to have your child participate in this research is voluntary. You are free to decline or withdraw participation of your child in the study at any time without injustice or loss of benefits. Just inform the study staff and the participation of your child in the study will be stopped. You do not have to give reasons for withdrawing your child if you do not wish to do so. Withdrawal of your child from the study will not affect the services your child is otherwise entitled to in this health facility or other health facilities.

For more information contact Dr. Priscilla Ngacha (Principle investigator) at 0724211219 from 8 am-5pm Department of Paediatrics and Child Health, Email mimungacha@gmail.com Lead supervisors: Dr. Bashir Admani, Senior lecturer, Department of Paediatrics and Child Health. Email pedbashir@yahoo.com. Dr. Boiface Osano, Lecturer, Department of Paediatrics and Child Health. Email bosano@uonbi.ac.ke, Prof. Ruth Nduati, Professor, Department of Paediatrics and Child Health, University of Nairobi. Email ruth_nduati2000@yahoo.com

KNHUoN/ERC/FORM/IC02

CONSENT FORM (STATEMENT OF CONSENT)

The person being considered for this study is unable to consent for him/herself because he or she is a minor (a person less than 18 years of age). You are being asked to give your permission to include your child in this study.

Parent/guardian statement

I have read this consent form or had the information read to me. I have had the chance to discuss this research study with a study counselor. I have had my questions answered by him or her in a language that I understand. The risks and benefits have been explained to me. I understand that I will be given a copy of this consent form after signing it. I understand that my participation and that of my child in this study is voluntary and that I may choose to withdraw it any time.

I understand that all efforts will be made to keep information regarding me and my child's personal identity confidential.

By signing this consent form, I have not given up my child's legal rights as a participant in this research study.

I voluntarily agree to my child's participation in this research study:

Yes No

I agree to have my child undergo ECG/EEG testing: Yes No

I agree to provide contact information for follow-up: Yes No

Parent/Guardian signature /Thumb stamp: _____ Date _____

Parent/Guardian printed name: _____

Researcher's statement

I, the undersigned, have fully explained the relevant details of this research study to the participant named above and believe that the participant has understood and has knowingly given his/her consent.

Printed Name: _____ **Date**: _____

Signature: _____

Role in the study: _____

APPENDIX 3: ASSENT FORM

KNH-UoN/ERC/FORM/IC02

UNIVERSITY OF NAIROBI (UoN)

COLLEGE OF HEALTH SCIENCES

P O BOX 19676 Code 00202

Telegrams: varsity

(254-020) 2726300 Ext 44355

KNH-UoN ERC

Email: uonknh_erc@uonbi.ac.ke

Website: http://www.erc.uonbi.ac.ke

Facebook: ttps://www.facebook.com/uonknh.erc

Twitter: @UONKNH_ERC
ttps://twitter.com/UONKNH_ERC

KENYATTA NATIONAL HOSPITAL (KNH)

P O BOX 20723 Code 00202

Tel: 726300-9

Fax: 725272

Telegrams: MEDSUP, Nairobi

ASSENT FORM

PROJECT TITLE: **PREVALENCE OF CARDIAC DYSFUNCTION AMONG PAEDIATRIC PATIENTS WITH CHRONIC KIDNEY DISEASE ON FOLLOW UP AT KENYATTA NATIONAL HOSPITAL.**

INVESTIGATOR: DR. PRISCILLA WAIRIMU NGACHA

We are doing a research study about how the heart functions in chidren with chronc Kidney Disease aged 18 years and belo, seen at Kenyatta National Hospital.

Permission has been granted to undertake this study by the Kenyatta National Hospital-University of Nairobi Ethics and Research Committee (KNH-UoN ERC Protocol No. _____)

This research study is a way to learn more about people with chronic kidney disease. At least 60 children will be participating in this research study with you.

If you decide that you want to be part of this study, you will be asked inform me about you and your illness. I will then examine you before doing some tests which are known as an echocardiogram and electrocardiogram which will help me see how well your heart is functioning. We will provide the results to your doctor and that will enable him to take care of you in a better way.

The tests we will perform are painless and pose no risk to you.
Not everyone who takes part in this study will benefit. A benefit means that something good happens to you. We think these benefits might be knowing the current condition of your heart function because this is a chronic disease.
When we are finished with this study we will write a report about what was learned. This report will not include your name or that you were in the study.
You do not have to be in this study if you do not want to be. If you decide to stop after we begin, that's okay too. Your parents know about the study too.
If you decide you want to be in this study, please sign your name.

I, _____, want to be in this research study.

_____ _____

(Signature/Thumb stamp) (Date)

APPENDIX 4: SWAHILI CONSENT/ASSENT FORMS

Form ya maelezo ya shahili (Swahili version).

Jina langu ni Dk. Priscilla Wairimu Ngacha, mwenyeji wa watoto wa hospitali ya Taifa ya Kenyatta akifanya shahada ya Mwalimu katika afya na watoto, katika shule ya Dawa, Idara ya Maabara ya Afya na Afya ya Watoto, Chuo Kikuu cha Nairobi.

Utafiti huu unafanyika kwa idhini ya hospitali ya Taifa ya Kenyatta - Chuo Kikuu cha Nairobi na Kamati ya Maadili na Utafiti (Protocole ya KNH-UoN ERC hakuna .....)

Ninafanya utafiti juu ya kazi ya moyo kwa watoto wenye ugonjwa wa figo wenye umri wa miaka 18 na chini, ambao umeonekana katika hospitali ya Taifa ya Kenyatta. Wana wa binti yako wanaombwa kushiriki katika utafiti kwa sababu yeye hukutana na masharti yanayotakiwa kuingizwa katika utafiti (vigezo vya kuingizwa).

Kusudi.

Matokeo ya utafiti itatusaidia kupata maelezo muhimu ambayo itasaidia katika Huduma ya watoto wenye ugonjwa wa figo sugu inayoonekana katika hospitali ya Taifa ya Kenyatta

Utaratibu.

Mahojiano haya yatachukua dakika 40-45, sitakuandika jina lake, na maelezo yote atakayotoa itahifadhiwa SAFE na haitashirikiwa na mtu mwingine yeyote. Ushiriki wake katika utafiti huu kabisa unategemea wewe na yeye

Ikiwa unakubali kushiriki katika somo hili, nitaendelea kuuliza maswali mfululizo na hatimaye kuandika majibu yako kwa maandishi

Nitafanya uchunguzi wa kimwili.

machini ya ECHO itatumiwa kuangalia moyo inavyofanya kazi na machini ya ECG itatumiwa kuangalia vile moyo inavyopiga. Uchunguzi huu unatusaidia kujua vile moyo inavyofanya kazi kwa mwili ya mtoto wako.

Nitawajulisha matokeo ya utafiti utakaofanywa na matokeo ya mtihani yanabaki siri. Matokeo pia yatatolewa kwa daktari ili kuboresha utunzaji wa mtoto wako.

Kusudi la idhini hii ni kukuuliza uniruhusu nifanye hivyo.

Ikiwa unapungua, hauathiri ubora wa utunzaji ambao utapewa.

Ikiwa unakubaliana kushiriki, nitawaomba kusaini fomu ya kibali. Hata hivyo fomu hii haiwezi kuunganishwa na jibu lako. Majibu yako binafsi yataonekana tu na mtafiti na itahifadhiwa kwa usalama, inapatikana tu kwa mtafiti.

Hatari kwako kama mshiriki katika utafiti.

Machini hizi zinazotumiwa kuangalia moyo wako hazina hatari yeyote ambayo tunajua.

Faida kwako kama mshiriki katika utafiti.

Tathmini ya bure ya kuangalia moyo unvyofanya kazi.

nakala ya matokeo yatatolewa kwa daktari na wewe.

Matokeo yatasaidia kuboresha usimamizi wake

Haki ya kujiondoa / kushiriki.

Ushiriki wa mtoto wako / wa binti katika utafiti huu ni hiari na uchaguzi wako wa kushiriki au hautaathiri ubora wa huduma aliyopewa mtoto wako wakati wowote.

Una haki ya kukataa kushiriki au kujiondoa wakati wowote

Una maswali yoyote?

Mzazi / mlezi ametoa kibali

Ndiyo 1

Hapana 2

Form ya shaha (taarifa ya kusha).

Taarifa ya Mshiriki.

Nimeisoma kibali hiki au nilisoma habari. Nimekuwa na fursa ya kujadili utafiti na mtafiti / msaidizi wa utafiti. Hatari na faida zimeelezwa kwangu. Ninaelewa kwamba ushiriki wangu katika utafiti huu ni hiari na kwamba nipate kuchagua kuchagua wakati wowote. Ninaelewa kwamba jitihada zote zitafanywa kuweka taarifa kuhusu utambulisho wangu binafsi.

Mimi, ... kukubali kushiriki katika utafiti juu ya kazi ya moyo kwa watoto wenye ugonjwa wa figo wenye umri wa miaka hadi 18.

Ninafanya hivyo kwa ufahamu kamili kwa madhumuni ya utafiti na taratibu zilizohusika. Taratibu hizi ni pamoja na kujaza dodoso la utafiti na kuwa machine ya ECHO na ECG itatumiwa kuangalia vile moyo inavyofanya kazi. Utafiti huu itatusaidia kujua ambavyo moyo wa mtoto unafaya kazi mwilini.

Saini ya mzazi / mlezi .....

Saini ya Shahidi .....

Tarehe ……

Taarifa ya Mtafiti.

Mimi, aliyechaguliwa, ameelezea kikamilifu maelezo muhimu ya utafiti huu wa utafiti kwa mshiriki aliyechaguliwa hapo juu na kuamini kuwa mshiriki ameelewa na ametoa idhini yake kwa hiari na kwa hiari

Jina la Mtafiti ..... Saini na tarehe .....

Nini ikiwa una maswali / wasiwasi baadaye?

Ikiwa una maswali zaidi au unahitaji maelezo zaidi au ufafanuzi kuhusu ushiriki katika utafiti, tafadhali piga simu au tuma ujumbe wa maandishi kwa Dk Priscilla Wairimu Ngacha, Idara ya Maabara ya Afya na Afya ya Watoto, Chuo Kikuu cha Nairobi. Nambari ya Simu ya Simu 0724211219. Barua pepe mimungacha@gmail.com. Wasimamizi wa kiongozi: Dk. Bashir Admani, Mhadhiri Mwandamizi, Idara ya Maabara ya Afya na Afya ya Watoto. Namba ya simu 0721967818. Barua pepe pedbashir@yahoo.com. Dk. Boniface Osano, Mkufunzi, Idara ya Maabara ya Pediatrics na Afya ya Watoto. Namba ya simu 0722646720, Barua pepe drosanob@gmail.com Prof Ruth Nduati, Profesa, Idara ya Maabara ya Pediatrics na Afya ya Watoto. Namba ya simu 0722235323, Barua pepe ruth_nduati2000@yahoo.com

Kwa habari zaidi juu ya haki zako kama mshiriki wa utafiti, unaweza kuwasiliana na katibu / mwenyekiti, Hospitali ya Taifa ya Kenyatta - Chuo Kikuu cha Nairobi na kamati ya utafiti no.2726300 Ext. 44102. Barua pepe uonbi.ac.ke.

Je, ni uchaguzi gani mwingine?

Uamuzi wako wa kushiriki katika utafiti ni wa hiari. Wewe ni huru kupungua kushiriki katika utafiti na unaweza kujiondoa kwenye utafiti wakati wowote bila udhalimu na kupoteza faida yoyote.

Funa ya kufuna (kwa watoto zaidi ya miaka saba na chini ya miaka 18)

Jina langu ni Dk. Priscilla Wairiu Ngacha, mwenyeji wa watoto katika hospitali ya Taifa ya Kenyatta anafanya shahada ya Masters katika watoto wa afya na afya ya watoto, katika shule ya Dawa, Idara ya Maabara ya Afya na Afya ya Watoto, Chuo Kikuu cha Nairobi.

Utafiti huu unafanyika kwa idhini ya hospitali ya Taifa ya Kenyatta - Chuo Kikuu cha Nairobi na Kamati ya Maadili na Utafiti (Protocole ya KNH-UoN ERC hakuna .....)

Ninafanya utafiti juu ya kazi ya moyo kwa watoto wenye ugonjwa wa figo wa muda mrefu wenye umri wa miaka 18 na chini, waliona hospitali ya kitaifa ya Kenyatta. Unatakiwa kushiriki kikamilifu katika utafiti kwa sababu unakabiliana na masharti ya kuingizwa katika utafiti

Mafanzo

Una ugonjwa sugu. Pia unakuja hospitali mara kwa mara kwa daktari ili uone kama unafanya vizuri. Ili kuwawezesha daktari kujua jinsi unavyofanya vizuri ni muhimu kujua vile oyo inavyofanya kazi katika mwili wako.

Kusudi

Tunataka kujua kama moyo wako unafanya kazi vizuri kwa sababu ya ugonjwa sugu ambao uko nao. Wakati mwingine kutokana na ugonjwa wako sugu moyo wako waweza kukosa kufanya kazi vizuri.

Taratibu

Ikiwa unakubali nitakuuliza baadhi ya maswali ili nisaidie kujua zaidi kuhusu wewe na ugonjwa wako. Nitawachunguza kabla ya kuangalia moyo wako na machine ya ECHO na ECG. Uchunguzi

unaofanywa na hizi machine utaniwezesha kujua vile moyo wako unafanya kazi mwilini wako. Tutatoa matokeo haya kwa daktari wako kila wakati na kisha atakuwezesha kwa njia bora zaidi.

Hatari au wasiwasi wowote

Machini hizi zinazotumiwa kuangalia moyo wako hazina hatari yeyote ambayo tunajua.

Unawafuna nini unafuna kusafu Au uwe na Maswali yoyote?

Ikiwa una maswali zaidi au unahitaji maelezo zaidi au ufafanuzi kuhusu ushiriki katika utafiti, tafadhali piga simu au tuma ujumbe wa maandishi kwa Dk Priscilla Wairimu Ngacha, Idara ya Maabara ya Afya na Afya ya Watoto, Chuo Kikuu cha Nairobi. Nambari ya Simu ya Simu 0724211219. Barua pepe mimungacha@gmail.com. Wasimamizi wa kiongozi: Dk. Bashir Admani, Mhadhiri Mwandamizi, Idara ya Maabara ya Afya na Afya ya Watoto. Namba ya simu 0721967818. Barua pepe pedbashir@yahoo.com. Dk. Boniface Osano, Mkufunzi, Idara ya Maabara ya Pediatrics na Afya ya Watoto. Namba ya simu 0722646720, Barua pepe drosanob@gmail.com Prof Ruth Nduati, Profesa, Idara ya Maabara ya Pediatrics na Afya ya Watoto. Namba ya simu 0722235323, Barua pepe ruth_nduati2000@yahoo.com

Kwa habari zaidi juu ya haki zako kama mshiriki wa utafiti, unaweza kuwasiliana na katibu / mwenyekiti, Hospitali ya Taifa ya Kenyatta - Chuo Kikuu cha Nairobi na kamati ya utafiti no.2726300 Ext. 44102. Barua pepe uonbi.ac.ke.

Taarifa nyingine

Hatuwezi kumwambia yeyote aliyeshiriki katika utafiti huu. Jina lako halitakuwa kwenye matokeo tutakayo ya pata kuoka machine hizi za ECHO na ECG. Huna budi kushiriki katika utafiti huu ikiwa hutaki. Hakuna mtu atakayekuwa na furaha na wewe. Tutakupa nakala ya karatasi hii kuweka.

_____ _____

Saini na jina la Tarehe ya uchunguzi

Taarifa ya Somo:

Utafiti huu wa utafiti umeelezewa kwangu. Nakubali kushiriki katika utafiti huu. Nimekuwa na nafasi ya kuuliza maswali. Ikiwa nina maswali zaidi, ninaweza kumuuliza daktari.

_____ _____

Saini na jina la tarehe ya somo

_____ _____

Saini na Jina la mzazi / mlezi wa kisheria Tarehe

APPENDIX 5: BUDGET

The following is the expected budget for the study

Category	Remark	Unit	Unit cost	Total (Ksh)
Proposal development	Printing drafts	1000	5	5000
	Proposal copies	1000	8	8000
Data collection	Stationery	400	10	4000
	Training research assistants	1	3000	3000
	Research assistant	20 weeks	1500/ week	30000
Data analysis	Statistician	1	30000	30000
Thesis write up	Printing drafts	1000	5	5000
	Printing thesis	10	1500	15000
Contingency fund				10000
ECG		60	500	30,000
ECHO		60	3000	180,000
ERC fee				5000
KNH Records access fee				500
Total				325,500

APPENDIX 6: TIME FRAME

Activity	**Estimated time**
Development of Proposal and presentation	Jan 2021- march 2021
Proposal Submission for ethical approval	November 2021- March 2022
Data Collection	March 2022- October 2022.
Data Analysis	November 2022
Thesis Writing	November 2022
Thesis Submission	December 2022

APPENDIX 7: PLAGIARISM TEST

PREVALENCE OF CARDIAC DYSFUNCTION AMONG PEDIATR PATIENTS WITH CHRONIC KIDNEY DISEASE AT KENYATTA NATIONAL HOSPITAL.

ORIGINALITY REPORT

13%	9%	10%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPER

PRIMARY SOURCES

1	archive.org	Internet Source
2	repository-tnmgrmu.ac.in	Internet Source
3	"Pediatric Hypertension", Springer Science and Business Media LLC, 2018	Publication
4	academic.oup.com	Internet Source
5	"Pediatric Kidney Disease", Springer Science and Business Media LLC, 2016	Publication
6	www.ncbi.nlm.nih.gov	Internet Source
7	www.omicsonline.org	Internet Source

APPENDIX 8: KNH-UON ERC APPROVAL

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

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

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

Ref: KNH-ERC/A/94

15th March, 2022

Dr. Priscilla Wairimu Ngacha
Reg. No. H58/34298/2019
Dept. of Paediatrics and Child Health
Faculty of Health Science
University of Nairobi

KENYATTA NATIONAL HOSPITAL APPROVED 15 MAR 2022 KNH/UoN-ERC P.O. Box 20723 - 00202, NAIROBI

Dear Dr. Ngacha,

RESEARCH PROPOSAL: PREVALENCE OF CARDIAC DYSFUNCTION AMONG PAEDIATRIC PATIENTS WITH CHRONIC KIDNEY DISEASE AT KENYATTA NATIONAL HOSPITAL (P749/09//2021)

This is to inform you that KNH-UoN ERC has reviewed and approved your above research proposal. Your application approval number is **P749/09/2021.** The approval period is 15th March 2022 – 14th March 2023.

This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used.
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by KNH-UoN ERC.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to KNH-UoN ERC 72 hours of notification.
iv. Any changes, anticipated or otherwise that may increase the risks or affected 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.
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. 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.
vii. Submission of an executive summary report within 90 days upon completion of the study to KNH-UoN ERC.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://research-portal.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely,

DR. BEATRICE K.M. AMUGUNE
SECRETARY, KNH-UoN ERC

c.c. The Dean, Faculty of Health Sciences, UoN
The Senior Director, CS, KNH
The Chairperson, KNH- UoN ERC
The Assistant Director, Health Information, KNH
The Chair, Dept. of Paediatrics and Child Health, UoN
Supervisors: Dr. Bashir Admani, Dept. of Paediatrics and Child Health, UoN
Dr. Boniface Osano, Dept. of Paediatrics and Child Health, UoN
Prof. Ruth Nduati, Dept. of Paediatrics and Child Health, UoN