MAKERERE UNIVERSITY

COLLEGE OF HEALTH SCIENCES

PREVALENCE AND FACTORS ASSOCIATED WITH MICROALBUMINURIA IN CHILDREN AND ADOLESCENTS WITH TYPE 1 DIABETES IN MULAGO AND NSAMBYA HOSPITALS IN UGANDA.

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DECLARATION

I, **SANYU KIRABO LUBWAMA**, hereby declare that the work submitted in this dissertation is original and is a result of my own work. Any work not done by me has been acknowledged and referenced accordingly. This dissertation has not been submitted to any other university or any other learning institution.

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LIST OF ABBREVIATIONS AND ACRONYMS.

ACEI – Angiotensin Converting Enzyme Inhibitors

ACR – Albumin Creatinine Ratio

DBP – Diastolic Blood Pressure

DKA – Diabetic Keto acidosis

DM- Diabetes mellitus

DN- Diabetic Nephropathy

ESKD- End Stage Kidney Disease

GAD – Glutamic Acid Decarboxylase antibodies

HbA1c- Glycosylated hemoglobin

IAA – Insulin Autoantibody

ICA – Islet Cell Antibodies

IDF- International Diabetes Foundation

ISPAD- International Society for Pediatric and Adolescent Diabetes

KDIGO- Kidney Disease Improving Global Outcomes

MAU- Microalbuminuria

NCD - Non communicable diseases

SBP – Systolic Blood Pressure

SSA- sub-Saharan Africa

T1D- Type 1 diabetes mellitus

UAER- Urinary Albumin Excretion Rate

WHO- World Health Organization

OPERATIONAL DEFINITIONS

Adolescent: Anyone aged between 10 years and 19 years (World Health Organization)

Child: Anyone below the age of 10 years.

Chronic Kidney Disease: is defined as abnormalities of kidney structure or function, present for > 3 months. (KDIGO guidelines 2017)

Diabetic nephropathy is a clinical syndrome characterized by persistent albuminuria (>300 mg/d or >200 μg/min) that is confirmed on at least 2 occasions 3-18 months apart, progressive decline in the glomerular filtration rate, and elevated arterial blood pressure.

End Stage Kidney Disease; is defined as a Glomerular Filtration Rate of < 15 ml/min/1.73 m2 or treatment by dialysis (KDIGO guidelines 2017)

Hypertension: is defined as average clinic measured Systolic Blood Pressure (SBP) and/or Diastolic Blood Pressure (DBP) ≥95th percentile for that particular age, sex, and height percentiles (Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents 2017)

Microalbuminuria is defined as an elevated Albumin Creatinine Ratio (ACR) 30 to 300 mg/g in males and 42 to 300 mg/g in females (because of lower creatinine excretion) in a 2 spot urine samples taken over 3months. (ISPAD 2018 guidelines)

Macroalbuminuria is defined as an ACR ratio > 300 mg/g in 1 urine sample. (ISPAD 2018 guidelines)

Optimal glycemic control is defined as HbA1c < 7.5%. (ISPAD 2018 guidelines)

Proteinuria is defined as a urine dipstick result of ≥ +.

Type 1 Diabetes Mellitus is an autoimmune disorder that occurs when T cells attack and destroy most of the βeta cells of the pancreas with reduced production of insulin and high blood sugar. In this study, Type 1 Diabetes(T1D) will be defined as any diabetes diagnosed before 20 years.

Hyperfiltration was defined as eGFR>120 ml/ min/1.73m^2 in children <12 years of age and >130 ml/ min/1.73m^2 in children older than 12 years

ABSTRACT

Background: Type 1 Diabetes mellitus (T1D) causes profound impact on children and families worldwide. There's a risk of poor growth, development, and macrovascular and microvascular complications among long term survivors. Over the last decade there has been a rise in T1D in Africa due to improvements in the rates of detection, reporting and survival of these patients. Diabetic nephropathy is common complication of T1D and more so in the developing world due to delayed diagnosis, poor control of blood sugar and inadequate treatment at an early stage. Microalbuminuria in persons with T1D indicates a potentially treatable and reversible stage of nephropathy.

Study Objectives: To determine the prevalence and the factors associated with microalbuminuria among children and adolescents with Type 1 diabetes mellitus attending Nsambya Hospital and Mulago hospital diabetic clinics.

Methods: This was a cross-sectional quantitative study conducted at Nsambya hospital and Mulago National Referral Hospital pediatric diabetic clinics in Kampala, Uganda. All patients aged between 18 months to 19 years with T1D were screened for eligibility and offered enrolment into the study. The following laboratory tests were done; urine albumin and urine creatinine measurement, random blood glucose, HbA1c, serum urea, serum creatinine. All tests were conducted during routine outpatient visits. Microalbuminuria was confirmed with elevated Albumin Creatinine Ratio (ACR) 30 to 300 mg/g in males and 42 to 300 mg/g in females in a 2 spot urine samples taken within 3 months. Data was collected with the aid of structured questionnaires and analyzed using STATA version 14. Bivariate analysis was used to test the association between microalbuminuria and independent variables; and then multivariable logistic regression models of odds ratios were used to determine the factors associated with microalbuminuria at 95% Confidence interval and $p< 0.05$ level of significance.

Results: A total of 153 children and adolescents were enrolled into the study. The median age of participants at the time of study was 8.4 years (6.12 to 12.09 years) and 83 (54.2%) of them were male. The median duration of T1D was 4.35 years with a high mean HbA1c of 11.2 ± 2.5%. The prevalence of microalbuminuria was 13.7% [95% CI: 9.1 – 20.2%] and the factors independently associated with microalbuminuria were duration of T1D less than 5 years (aOR 27.44, 95% CI (3.32,226.77)), hospitalization in the previous year (aOR 5.39, 95% CI (1.21-23.94)), hypertension (aOR 19.12, 95% CI (3.39,107.83)) and HbA1c (aOR 1.41, 95% CI (1.12-1.783)).

Conclusion: The prevalence of microalbuminuria at 13.7% is relatively high. Duration of diabetes for less than 5 years, hypertension, elevated HbA1c and history of hospitalization in the previous year are factors that influence the development of microalbuminuria in T1D patients in our setting. Despite ISPAD guidelines, early and more frequent screening for microalbuminuria irrespective of age or duration of the disease may be warranted in children in our setting. Furthermore, emphasis on aggressive glycemic control even early after diagnosis is crucial and cannot be overstated.

Key words; microalbuminuria, Type 1 Diabetes mellitus, diabetic nephropathy, children

CHAPTER ONE: INTRODUCTION

1.0 Background

Globally, the prevalence of Non Communicable Diseases (NCD) including diabetes mellitus (DM), cardiovascular diseases, cancers and chronic respiratory diseases is on the rise (1). In 2019, the International Diabetes Federation (IDF) estimated the total number of people with Diabetes Mellitus (DM) to be 463 million, with T1D contributing 5%–10% of these cases. The 2019 IDF report estimates that more than 1.1 million children and adolescents are living with T1D and the incidence is increasing by approximately 3% worldwide(2).

The situation in Africa is unfortunately no different; the total number of people with T1D in Africa is rising. It is estimated that there were 25,800 children and adolescent cases as of 2019 and there are 10,300 new cases diagnosed per year(2). Since data in this area is scarce, this is thought to be a gross under estimate and due to the limited awareness of DM among children and adolescents (3). Therefore many of such patients may die even before a diagnosis is made(4). Mortality in these children may be ascribed to other factors such as cerebral malaria or gastroenteritis and as a result, their deaths will never be included in diabetes epidemiologic data(4).

In Uganda, pediatric diabetes is greatly understudied although anecdotal facility based data indicate a rise in T1D, which silently accounts for a high morbidity and a high mortality among people aged <18 years(5). A study done in 2019 reported that Uganda had an estimated 1100 children under the age of 18 years with diabetes in only 32 health facilities(6).

Diabetic nephropathy (DN) is the leading cause of End-stage Kidney Disease (ESKD) and the care of patients with diabetes and DN contributes significantly to health care costs in the developed world(7). Among the patients with T1D, approximately 20%-30% will eventually develop DN(8). In the absence of kidney disease, individuals with T1D experience mortality rates similar to those in the general population(9).

Although overt DN or kidney failure are uncommon during childhood or adolescence, diabetic kidney disease in susceptible patients almost certainly begins soon after onset of DM(10). This

may accelerate during adolescence, leading to microalbuminuria or incipient DN(10). Therefore, all diabetes patients warrant ongoing assessment of kidney function and screening for the earliest manifestations of kidney injury(10).

Presence of trace amount of albumin in urine (microalbuminuria) has a good prognostic value in predicting early kidney damage (initial nephropathy)(11). This provides an opportunity to institute interventions early, like strict glucose control and Angiotensin Converting Enzyme (ACE) inhibitors to deter progression to ESKD(12). Approximately, one-third of diabetes patients develop microalbuminuria after 15 years of the onset of disease, whereas full nephropathy requiring dialysis or kidney transplantation can develop in nearly half of the patients developing microalbuminuria(13).

Internationally, the reported prevalence of microalbuminuria in developed countries is far lower than rates reported in Africa. The United States of America reported 3.3% in 2015, 5% in the United Kingdom, Denmark 1.9% and 3.3% in German diabetic children (14-16). In African countries, data for microvascular complications like microalbuminuria especially in children is greatly understudied and hence scarce. In 214 Rwandan youth with Diabetes, 20% had microalbuminuria, 5% nephropathy, whereas in Tanzania, of 99 children with a mean diabetes duration of only 5 years, 29% had microalbuminuria(4). This can be attributed to the poor metabolic control, poor access to insulin, and limited screening and diagnostic resources of microalbuminuria in Africa compared to the developed world(4, 17).

The long-term deleterious effects of hyperglycemia on various end-organs necessitates regular monitoring of organ functions to initiate early intervention to prevent diabetes associated complications. Unfortunately, in many low-income countries like Uganda, tests to detect microalbuminuria and monitor kidney function are not routinely done yet this would improve outcomes and address some of the gaps in the care of children with diabetes. This study therefore aimed to determine the prevalence and the factors associated with microalbuminuria among children and adolescents with Type 1 diabetes mellitus attending Nsambya Hospital and Mulago hospital diabetic clinics. These findings will provide data that will be used to improve management of children with T1D and provide a basis for further research.

1.1 Problem Statement

Diabetic Nephropathy is one of the most devastating complications in patients with T1D, and a major predictor of premature death(18). The cumulative incidence of hospitalization due to diabetic nephropathy is approximately 20% after diagnosis of T1D(18).

Globally one third of patients with T1D develop microalbuminuria, and about 15% to 25% develop persistent proteinuria during the first 20 years of living with the T1D(18). The African race has been seen to be associated with increased susceptibility to diabetic nephropathy with higher levels of microalbuminuria in diabetic Africans with short duration of TID(19). Microalbuminuria may also rapidly progress to macro albuminuria in the African race thus ESKD necessitating more vigilant screening among African patients(19).

Furthermore, there is vast scientific evidence showing that higher levels of HbA1c are associated with increased risk of development of microalbuminuria in T1D patients (10, 11, 17, 19-22). In Uganda, patients with T1D have poor glycemic control with average HbA1c at 11% putting them at an even higher risk of microalbuminuria and other microvascular complications(23). Microvascular consequences like diabetic nephropathy are reportedly more likely to appear in late adolescence and adulthood as a result of long standing history of poor metabolic control. However among African children and adolescents, these consequences are appearing earlier after a short diabetes duration of about 4 years and in the younger population as reported in Rwanda, Nigeria and Tanzania (4, 17, 19) showing the need for more intense monitoring among our patients.

Pediatric Diabetic clinics in Uganda like other countries in Africa, do not routinely test for microalbuminuria in the Diabetes comprehensive health care package. Therefore, it is possible that many children with microalbuminuria are diagnosed late and so no early interventions put in place to curb the progression to long term ESKD.

1.2 Justification

Identification of the burden and factors associated with microalbuminuria in our setting will assist the clinicians in designing guidelines for better screening and prevention of long-term

ESKD. With early identification of microalbuminuria, children with T1D benefit from therapy which ultimately prevents progression to ESKD. Additionally, this data will inform clinicians and policy makers on the need for screening and will play a role in advancing advocacy for better care among children with T1D.

A study was done 11 years ago in Uganda at the diabetes clinic in Mulago National Referral hospital that revealed that more than 60% of children had microalbuminuria(20). The burden of microalbuminuria was high however there was a possibility that the prevalence was over estimated due to methodological limitations which included use of only one spot urine sample for microalbuminuria. Use of only one sample has a high chance of false positive because microalbuminuria in 50% of the patients is transient and does not necessarily progress towards nephropathy(24). There are also several confounding factors that can result into a false positive like seminal fluid, menstruation, fever, urinary tract infections and strenuous exercise hence the need for more than one sample to reduce the chance of false positives.

Further still, in the past 11 years the levels of diabetes care have improved with availability of trained pediatric endocrinologists and other health care professionals, more availability of insulin, educational materials for patients, better blood glucose testing and monitoring supplies.

This study therefore was done to assess the burden of microalbuminuria according to the current International Society for Pediatric and Adolescent Diabetes (ISPAD) and American Diabetes Association (ADA) guidelines using one screening sample and confirm the positivity with another sample within three months of the first positive urine test and also assess any change in the burden of microalbuminuria as earlier noted. The baseline kidney function of all patients with Type 1 diabetes mellitus enrolled in the study was also calculated using the estimated glomerular filtration rate (eGFR) bringing insight on kidney function in patients with T1D in our setting.

1.3 Research Questions

1.3.1 Primary Questions

1. What is the prevalence of microalbuminuria in children and adolescents with T1D attending the pediatric diabetic clinics in Mulago and Nsambya Hospital?

2. What are the factors associated with microalbuminuria among children and adolescents with T1D?

1.4 Research Objective

1.4.1 Broad objective

The aim of the study was to determine the prevalence and factors associated with microalbuminuria among children and adolescents with T1D being managed and followed up at both Nsambya and Mulago Hospital pediatric diabetic clinics in Kampala, Uganda.

1.4.2 Specific objectives

The specific objectives of the study were as follows:

1. To determine the prevalence of microalbuminuria among children and adolescents with T1D attending diabetic clinics in Mulago and Nsambya Hospitals.
2. To determine the factors associated with microalbuminuria in children with T1D attending diabetic clinics in both Mulago and Nsambya Hospitals.

1.4.3 Conceptual Framework

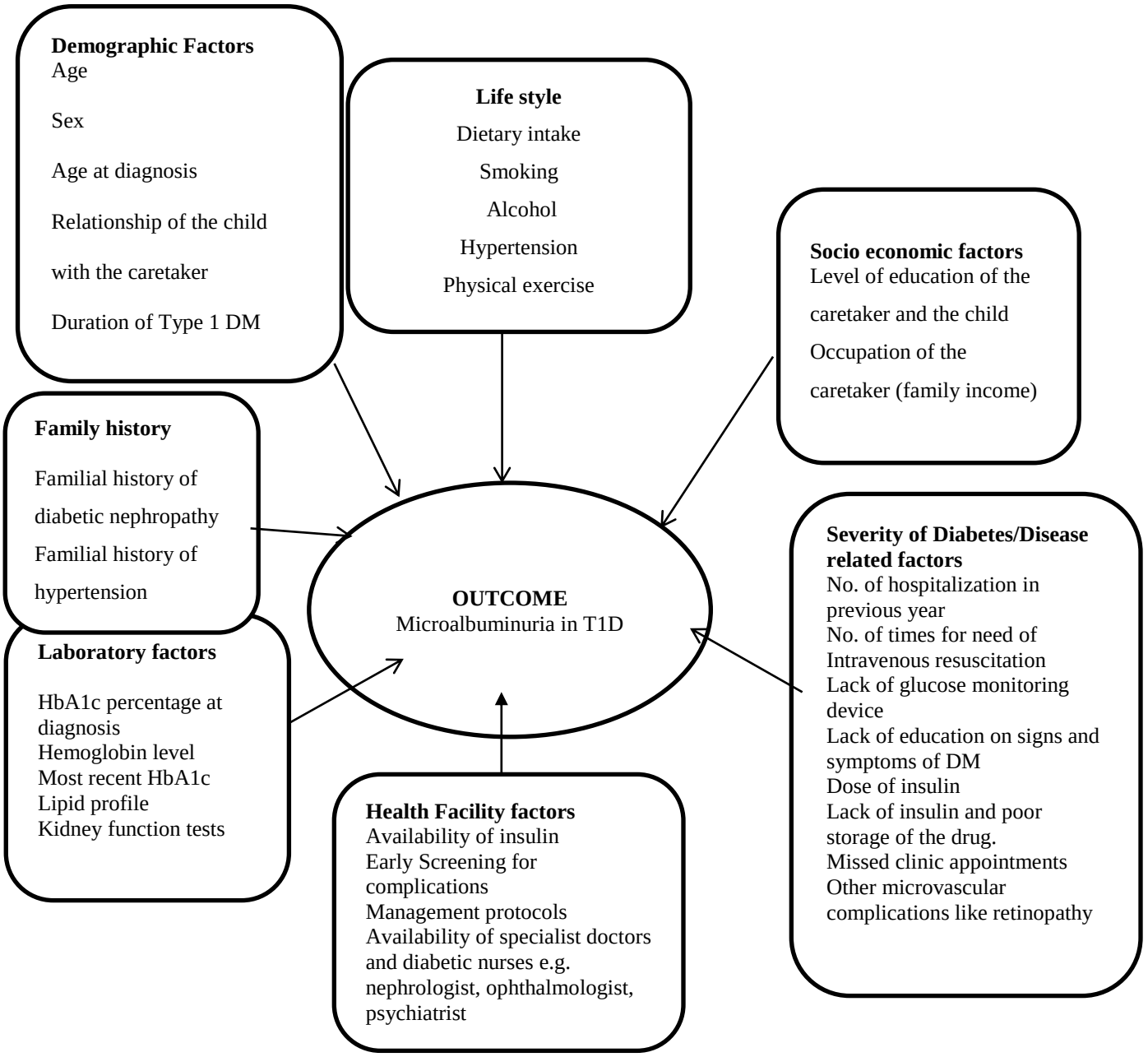


Figure 1: Conceptual Framework showing factors associated with microalbuminuria in T1D

Microalbuminuria is strongly associated with longer diabetes duration, higher HbA1c, female sex, BMI, older age, and above-normal systolic and diastolic BP. The health facility factors will not be entirely studied in this study. The scope of this study included demographic factors, family history, disease related factors, social factors and laboratory factors.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

Diabetes mellitus a common disorder of insulin production and/or insulin action that results in uncontrollably high sugar levels (hyperglycemia) with associated abnormalities of carbohydrate, fat, and protein metabolism(25). The pathogenesis ranges from autoimmune destruction of the β-cells of the pancreas that produce insulin leading to insulin deficiency to abnormalities that result in resistance to insulin action all these leading to inadequate glucose at a cellular level(26). T1D leads to an increased risk of morbidity and early mortality due to chronic complications affecting both the micro and macro-vasculature. Diabetic nephropathy (DN) is one of the most serious chronic complications of T1D, affecting approximately 20-30%(10) of patients and increasing the risk of cardiovascular disease(21) and end-stage kidney disease. Microalbuminuria is considered to be the most important predictor of DN and represents a potentially reversible stage of diabetic nephropathy. It is also associated with the development of hypertension and cardiovascular disease (10, 21, 27).

While more severe stages of DN take decades to develop and are thus rarely observed in childhood, kidney biopsies as early as 1.5–5 years after diabetes onset show structural changes characteristic of DN in both adults and children(28). This suggests that the DN course begins soon after diabetes onset and that this early interval may provide a critical time-frame for detection and intervention in the disease course, warranting intensive monitoring and modification of risk factors in children and adolescents. Unfortunately, our current tools for early diagnosis of DN in children and adolescents are limited.

2.1 Diabetes Mellitus

Diabetes Mellitus is classified as either type 1 DM, type 2 DM or gestational DM and acquired disorder(2). In children, the most common form of diabetes is type 1, due to destruction of the β cells of the pancreas, with eventual complete lack of insulin secretion(26). Type 2 DM in children is also on the increase in association with the increase in childhood obesity(29). It results from peripheral and hepatic resistance to insulin coupled with inability of the pancreatic β cells to compensate(30). Recently a new classification of diabetes has been proposed called the β cell-centric classification which pre-supposes that all diabetes originates from a final common

denominator, the abnormal pancreatic β cell (31). It proposes that interactions between genetically predisposed β cells with a number of factors, including insulin resistance (IR), susceptibility to environmental influences, and immune dysregulation/inflammation, lead to the range of hyperglycemic phenotypes within the spectrum of diabetes(31). DM is associated with acute and chronic complications that contribute to excess morbidity and mortality in individuals, especially in developing countries(32).

2.2 Burden of Diabetes Mellitus

Worldwide, DM is one of the most common chronic diseases in children and T1D accounts for over 90% of the cases of diabetes. In total, 1,110,100 children and adolescents younger than 20 years are estimated to have T1D globally. It is estimated that around 98,200 children and adolescents under the age of 15 years are diagnosed with T1D annually(2). The incidence of T1D in children varies widely, and the incidence rates are correlated with the frequency of human leukocyte antigen (HLA) susceptibility genes in the general population often higher in Caucasian populations (33). Finland has the highest incidence of T1D with 36.5 per 100 000, Sweden with 27.5 per 100 000, Canada (Prince Edward Island) with 24.5 per 100 000, and Norway (eight counties) with 21.2 per 100 000(33). In Asia, the incidence of T1D is low compared with Caucasians(34). This could be explained by a low frequency of high-risk HLA alleles or different genetic and environmental interactions that might be involved in the etiology of T1D(34).

Likewise in Africa, the reported incidence is also low, even though diabetes overall is not rare in Africa, but there is limited information from the region (32). The presence of any of the antibodies, GAD-65, ICA, IAA and IA-2 increase the risk of T1D(35). In general, 70% of people with new-onset T1D will have a positive antibody if only one antibody is measured, whereas 90% will have at least one antibody when all four are measured(35). Generally a rise in T1D incidence has been observed globally in recent decades(2, 32). It is likely that a multifactorial process leading to a disequilibrium between protective and diabetogenic factors is the cause of this increase. This in turn causes the acceleration of the diabetic process, causing an increase in childhood onset, therefore leading to an overall increase in the incidence of T1D(36).

In some reports there has been a disproportionately greater increase in those under the age of five years and in developing countries or those undergoing economic transition in recent decades(32). Type 2 diabetes is becoming more common and accounts for a significant proportion of young-onset diabetes in certain at-risk populations (37). There are generally no significant gender differences in the incidence of diabetes, even though some differences are observed in some populations. However, a male gender bias is often observed in older adolescents and young adults (38).

2.3 Management of Diabetes Mellitus

The main goals of treatment of T1D are to achieve glycemic control closest to physiologic normality as possible, avoid acute complications, minimize the risk of long-term microvascular and macrovascular complications, and assist the child and family in achieving normal growth and development(39). DKA and hypoglycemia are the most significant acute complications of diabetes and its treatment, and both complications pose a significant risk of morbidity and mortality(40). Children with T1D are also at risk for the long-term complications of diabetes, most notably microvascular complications such as retinopathy, nephropathy, and neuropathy. Longer term, macrovascular disease may occur, leading to strokes and heart disease(25).

The basic components of DM management are insulin administration by either subcutaneous injection or insulin pump, lifestyle modification including physical exercise and nutrition management (implementation of an individualized meal plan with prandial insulin adjustments improves glycemic control), blood glucose monitoring, the avoidance of severe hypoglycemia, and the avoidance of prolonged hyperglycemia or DKA(21, 41).

2.4 Diabetic nephropathy

Diabetic nephropathy is defined by increased urinary albumin excretion (UAE) in the absence of other kidney diseases(42). It is a major cause of morbidity and mortality amongst young adults with T1D. In the absence of diabetic nephropathy, mortality in patients with T1D is similar to that in the general population, whereas it is significantly higher in patients with abnormal urinary Albumin Excretion Rate(AER)(21). It also increases the risk of death, mainly from cardiovascular causes. In diabetic patients with proteinuria the relative mortality is about 40

times higher than in the diabetics without proteinuria making kidney damage a serious complication of diabetes mellitus(11).

The changes occurring in the kidney in patients with T1D are generally classified into five stages, reflecting specific and progressive alterations in kidney morphology and function.

1. The earliest stage is characterized by glomerular hypertrophy, hyper filtration, and hyper perfusion(21). Microalbuminuria may be present but is readily reversible with insulin treatment. The increases in kidney size and Glomerular Filtration Rate (GFR) may normalize or may persist in some patients. Blood Pressure (BP) typically is normal during this period. There is no evidence of histological lesion in glomeruli or vascular structures(10).
2. This is followed by a stage of subclinical morphological changes over the next 1.5 - 7years. These changes include glomerular and tubular basement membrane thickening which is then followed by mesangial matrix expansion with an increase in fractional volume of the mesangial matrix typically observed 5–7 years after diabetes onset(28). Microalbuminuria is only present during periods of poor metabolic control and with strenuous exercise. Many patients continue in this stage for many years or throughout their lives. Toward the end of this silent period, urinary albumin excretion (UAE) will begin to rise within the normal range in a set of patients that will ultimately develop microalbuminuria.
3. The hallmark of the third stage, that usually develops 7– 10 years after diagnosis and found in about a third of patients, is the appearance of microalbuminuria, which is widely accepted as the first clinical sign of DN. GFR is normal or still elevated. Incipient increase in BP (about 3 mmHg/year), albeit still within the conventional age-corrected normal range, may be found in this stage. In adolescents, an increase in nocturnal systolic BP precedes the development of microalbuminuria(27). Some long-standing normoalbuminuric (NA) patients may have reduced GFR associated with more advanced glomerular lesions and, probably, an increased risk of progression(43). Pathology shows a progression of the glomerular lesions. Once microalbuminuria develops, urine albumin excretion continues to rise, particularly in presence of uncontrolled risk factors, leading to overt proteinuria. However in 30 - 40 % of the patients with microalbuminuria will spontaneously regress to normoalbuminuria(28).

4. The onset of the fourth stage, is heralded by overt (clinical) proteinuria (formerly termed macro albuminuria AER>200µg/min or 300mg/24 hours), that is commonly associated with the presence of other microvascular complications; particularly retinopathy(10). Increasing albumin excretion rate (AER) is generally accompanied by a steady rise in BP (by about 3 mmHg/ year) and declining GFR in most patients (by about 10 ml/min per year). That may be slowed but not necessarily stopped. Proteinuria is an ominous finding, as studies report a 40-fold increase in mortality in this group(11).
5. The final stage occurs with the progression to ESKD, usually 5–10 years after the appearance of overt proteinuria(10). These various lesions progress at different rates within and between different patients with T1D. However, by the time advanced DN with kidney insufficiency sets in, all patients display marked mesangial expansion and GBM thickening as well as interstitial expansion and fibrosis, tubular atrophy and glomerulosclerosis(28).

There are few reports of young children or teenagers with T1D of short duration (4–11 years) with accelerated development of clinical DN and associated glomerular lesions typical for this stage of the disease(22, 44).

2.4.1 Diabetic Nephropathy and Microalbuminuria

The term microalbuminuria has been used to describe an amount of albumin in the urine which is less than can be detected by ordinary clinical tests but is otherwise still associated with future disease. Microalbuminuria is an early sign of diabetic kidney disease. It precedes persistent proteinuria and represents a potentially reversible stage of diabetic nephropathy. Once persistent proteinuria has set in it is only possible to slow but not to halt the progression towards ESKD(11). Additionally, microalbuminuria is also considered to be a predictor for cardiovascular disease both among diabetic and non-diabetic subjects and is one of the components of the metabolic syndrome(21). In the Steno Diabetes Center (Gentofte, Denmark) cohort, T1D patients with isolated microalbuminuria had a 4.2-fold increased risk of cardiovascular disease(45).

Assessing microalbuminuria in a random urinary sample, instead of an overnight timed urine collection, is the easiest method to carry out in an office setting and provides accurate results. Regardless of the procedure used, at least two of three samples over a 3- to 6-month period

should confirm microalbuminuria. Because albumin excretion rate has an intraindividual coefficient of variation of approximately 40% multiple positive results are required for confirmation(10, 46). Urine voided in the morning is preferable because of the known diurnal variation in albumin excretion and postural effects. Current recommendations from the American Diabetes Association and the International Society for Pediatric and Adolescent Diabetes regarding screening for microalbuminuria in young people with T1D suggest annual testing after 11 years of age and after diabetes duration of 2-5 years(21).

2.4.2 Prevalence of Microalbuminuria.

Internationally the reported prevalence of microalbuminuria in developed countries is far lower than rates reported in Africa. The United States of America reported 3.3% in 2015, 5% in the United Kingdom, Denmark 1.9% and 3.3% in German diabetic children (14-16). In African countries, data for microvascular complications like microalbuminuria especially in children is greatly understudied and hence scarce. An incidence of microalbuminuria of 18% was reported by Svenson et al. from a 15-year follow-up study of 94 children diagnosed with T1D in Sweden (47).

In 214 Rwandan youth with Diabetes, 20% had microalbuminuria, 5% nephropathy, whereas in Tanzania, of 99 children with a mean diabetes duration of only 5 years, 29% had microalbuminuria(4). This can be attributed to the poor metabolic control, poor access to insulin, and limited screening and diagnostic resources of microalbuminuria in Africa compared to the developed world(4, 17). Nigeria reported a high prevalence of microalbuminuria of 60% in 20 patients with Type 1 diabetes receiving care in Port Harcourt Nigeria in 2020(48). This prevalence is similar to a study done 11 years ago in Uganda at the diabetes clinic in Mulago National Referral hospital that revealed that more than 60% of children had microalbuminuria(20). The burden of microalbuminuria was high however there was a possibility that the prevalence was over estimated due to methodological limitations.

2.4.3 Factors associated with microalbuminuria.

The great majority of patients in whom risk factors for microalbuminuria in T1D have been studied, are of European descent. Publications on kidney involvement in T1D from Africa are few and cross-sectional(17, 49, 50). Factors that have been identified to influence

microalbuminuria include glycemic control, duration of diabetes, puberty, age at onset, female gender, higher Blood Pressure (BP), smoking, hyperlipidemia, and family history of diabetic complications, including genetic factors(10, 11, 28). Some of these factors, such as disease duration or family history, are clearly not modifiable, whereas others, including the degree of metabolic control achieved or the presence of hypertension, may be amenable to highly effective interventions.

2.4.3.1 Glycemic control.

Data from adolescents aged 13–17 years at entry into the Diabetes Control and Complications Trial(51) demonstrate the importance of blood glucose control for the development of microvascular complications; a 40% risk reduction for the development of microalbuminuria was experienced in the intensively treated group compared with the conventionally treated group. This shows that poor glycemic control is an important risk factor of microalbuminuria. Globally, more recent studies in Rwanda, South Africa and Kuwait have further strengthened this phenomenon showing patients with high HbA1c developing micro and macro albuminuria compared to their well-controlled counterparts (17, 19, 22).

2.4.3.2 Age at onset of Diabetes; impact of puberty.

Regarding T1D, the risk of developing ESKD is very low for patients diagnosed prior to age 5; at older ages, the relationship of age to progression to ESKD is uncertain(10). A review stated in Pediatric Nephrology journal published in 2008 states that despite some inconsistencies among studies in which the importance of pre-pubertal diabetes duration in relation to development of microalbuminuria have been investigated, it can be concluded that pre-pubertal diabetes duration contributes to the risk of microalbuminuria, but the younger age at onset or longer pre-pubertal diabetes duration seems to prolong the time to development of microalbuminuria or later ESKD(10). It is likely that factors during puberty have a major adverse effect on the risk of developing microvascular complications(10).

2.4.3.3 Duration of Diabetes.

Besides hyperglycemia, diabetes duration is recognized as a major contributor to microalbuminuria. The increased risk of microalbuminuria as the earliest sign of DN was related

to diabetes duration, therefore the American Diabetic Association, ISPAD have recommended that annual screening for microalbuminuria should only be done after at least 5 years of diagnosis of T1D. However, according to a study in Kuwait, 65% of patients with diabetic nephropathy had T1D for less than 5 years(22). A report on Childhood Diabetes in Africa in 2016 also reported presence of microalbuminuria in among children with a diabetes duration of less than 5 years in Rwanda and Tanzania(4, 19). This shows that children in Africa may be at a higher risk of developing these microvascular complications earlier hence monitoring in these children might need to be started earlier and done more frequently.

2.4.3.4 Dyslipidemia

A study done in 2009 involving a total of 1,066 subjects, aged 10–16 years, who had developed T1D before the age of 16 years, were recruited throughout four United Kingdom regions (East Anglia, Birmingham, Bristol, and Oxford). This study, examined lipid levels in relation to changes in albumin excretion, as a continuous variable, and the development of microalbuminuria. Increased total cholesterol and non-HDL cholesterol levels were independently related to ACR during follow-up but overall, lipid levels were higher in subjects developing microalbuminuria when compared with normoalbuminuric subjects(52).

2.4.3.5 Smoking

Smoking is associated with an increased risk of developing persistent microalbuminuria(21). A study published in the Journal of American Medical Association found the prevalence of increased albumin excretion rates was 2.8 times higher in smokers than nonsmokers. This was evaluated in 359 young subjects with T1D aged at least 14 years with a diabetes duration of 5 years. Albuminuria improved significantly when subjects ceased smoking. It is concluded that cigarette smoking is an independent risk factor and is associated with the development and progression of early diabetic kidney damage (albuminuria)(53).

2.4.3.6 Genetic factors

Genetic susceptibility may be an important determinant of both the incidence and severity of microalbuminuria and diabetic nephropathy. The likelihood of developing diabetic nephropathy is markedly increased in patients with a diabetic sibling or parent who has diabetic nephropathy;

these observations have been made in both type 1 and type 2 diabetes(10). The risk that diabetic siblings of diabetic proband with nephropathy will also have nephropathy was three- to fourfold higher compared with diabetics whose siblings had no nephropathy(54).

2.4.3.7; Race

In an interethnic study done in South Africa to determine the prevalence and incidence of and risk factors for, microalbuminuria among urban Africans with T1D, it was found that microalbuminuria, and severe hyperglycemia, are common in diabetic Africans with short duration TID as compared to the white patients. Microalbuminuria may rapidly progress to macroalbuminuria among the African race increasing the susceptibility to diabetic nephropathy(19).

2.4.3.8 Hypertension

High blood pressure and alterations in the circadian BP rhythm have been associated with the risk of developing nephropathy and retinopathy in youth with T1D. In an English cohort of young people with T1D, daytime Diastolic Blood Pressure (DBP) was independently associated with progression to microalbuminuria i.e. a 1 mmHg rise in daytime DBP increased the risk of developing microalbuminuria by about 11%. Increasing albumin excretion, even in the normal range, may be associated with parallel rises in BP according to this study(27, 55). A family history of hypertension confers increased susceptibility to the development of microalbuminuria according to a study done in Spain. The risk was reported to be higher if mother alone was affected compared to having a sibling affected by hypertension(56).

2.4.3.9 Retinopathy

Prevalence of microalbuminuria is related to the presence of retinopathy. This was described in a study to identify prevalence and factors associated with microalbuminuria among 312 Type 1 DM patients attending in three hospitals in two Spanish regions. Laser treated retinopathy among other factors was identified as one of the major factors associated with development of microalbuminuria(56).

2.4.3.10 Female Gender

Female gender has been identified as an independent risk factor associated with the presence of microalbuminuria. This phenomenon has been described in several studies, including Botswana in Africa and the Oxford Regional Prospective Study (49, 57, 58). Factors hypothesized to be driving this difference include changes in growth hormone release and low insulin-like growth factor-1 levels, more commonly reported in girls with T1D(58). Furthermore, onset of puberty is earlier in girls and, therefore, adolescent girls may have had higher cumulative exposure to puberty hormones, as compared to adolescent boys(57).

Other risk factors for microalbuminuria were described in this longitudinal study of 972 youth with T1D at The Children's Hospital in West Mead. Early elevation of AER at first complication assessment was a significant risk factor for the later development of persistent microalbuminuria. The modifiable risk factors identified for microalbuminuria were higher Body Mass Index (BMI), hypercholesterolemia and glycemic control(59).

2.4.4 Management of Microalbuminuria

Therapeutic interventions can be divided into those that prevent the onset of complications (primary prevention) and those that slow or halt their progress (secondary intervention). The goal of a prevention strategy involves changing potentially modifiable risk factors: optimizing blood glucose control, discouraging smoking, encouraging healthy diet, controlling BP, and encouraging healthy exercise(10, 21, 41, 42, 60).

As regards to secondary intervention, ISPAD guidelines recommend treatment with angiotensin converting enzyme inhibitors (ACEI) or Angiotensin Receptor Blockers (ARB) for young people with persistent microalbuminuria and no other recognized cause of kidney disease(21). They have been effective and safe in children in short-term studies and in adults(24, 61), ACEI and ARBs reduce progression from microalbuminuria to macro albuminuria and increase the regression rate to normoalbuminuria(62). However, there are still some concerns regarding the long-term use of ACEIs in young people without hypertension. Young people with microalbuminuria would potentially be taking ACEI for decades. And the key side effects

include cough, hyperkalemia, headache, and impotence and the potential risk of congenital malformations when used during pregnancy need to be explored(10).

2.5 Conclusion

In patients with diabetes, mortality rates increase excessively with the onset and progression of microalbuminuria. Screening for and preventing the development of microalbuminuria may prevent end stage kidney failure and cardiovascular disease which can be fatal. Keeping in view these facts we intend to describe the prevalence and factors associated with microalbuminuria in this study.

CHAPTER THREE: RESEARCH METHODS

3.0 Introduction

3.1 Study design

This study was a quantitative, cross-sectional study to determine the prevalence and factors associated with microalbuminuria among children and adolescents attending the pediatric diabetic clinics at Mulago and Nsambya Hospitals.

3.2 Study sites

The study was conducted at two sites, the Pediatric Diabetic Clinic of Mulago National Referral Hospital, Kampala Uganda and the Pediatric Diabetic clinic at Nsambya Hospital Kampala Uganda. Uganda is a landlocked country situated in East Africa which covers an area of 241,038 square kilometers with an estimated population of 40.3 million by mid-year 2019 according to Uganda Bureau of statistics report in 2019(63). Uganda is one of the 48 countries of the International Diabetic Federation (IDF) African region.

Mulago Hospital is a National Referral and Teaching Hospital which receives children referred from health facilities within and outside Kampala, the Capital City of Uganda. The hospital has a total bed capacity of 1500 in-patient beds and attends to over 480,000 patients annually. The Department of Pediatrics and Child Health runs 8 specialized clinics, of which the diabetic clinic is part. The clinic has 225 registered patients and is run by medical officers, pediatric residents and one pediatric endocrinologist. The majority, (75%) of the patients attending the diabetic clinic are below 18 years and most of them come from Kampala and surrounding districts. The clinic runs once a week on Tuesdays (8am - 4pm) with an average of 20 patients per day. The attending doctor does a clinical evaluation that includes a history and physical examination, followed by a random blood glucose. Other tests like a complete blood count showing the white blood cell count with differentials, hemoglobin level and platelet count, glycosylated hemoglobin and urinalysis normally depend on the patient's clinical presentation and on the attending doctor's clinical judgment. Depending on the doctor's assessment of the patient's clinical features and laboratory parameters the patient is managed as either an outpatient or hospitalized to Acute Care Unit (the pediatric medical emergency ward) for cases that require further monitoring and treatment.

St. Francis Hospital Nsambya is a Catholic Mission Hospital founded in 1903, owned by the Archdiocese of Kampala and managed by the Little Sisters of St. Francis of Assisi. It has a bed capacity of 361 beds and is involved in patient care, research, and teaching. It offers specialist services in surgery, internal medicine, pediatrics, obstetrics, and gynecology and has an average of 19,000 admissions every year and receives an average 300 out-patients every day. The Department of Pediatrics and Child Health runs 5 specialized clinics, including the diabetic clinic. The clinic, which is run by nursing officers and a pediatrician runs once a week on Fridays (8am - 1pm). It has approximately 250 active patients aged 5- 19 years and they review about 15 to 22 patients per clinic day. The pediatrician in charge does a clinical evaluation that includes a history and physical examination, followed by relevant laboratory investigations for that visit which include a random blood glucose, urinalysis and other laboratory tests as required. Patients are usually managed as outpatients, or if acutely ill admitted on the pediatric ward for stabilization.

These two sites were identified for the study because they are the largest well-established and fully functional pediatric diabetic clinics in Kampala. They have an active registry of children and adolescents diagnosed with T1D coming from Kampala and surrounding districts. This allows for assessment of prevalence of T1D but also prevalence of complications of T1D and factors associated with the disease.

Mulago pediatric Diabetic clinic and St. Francis Hospital Nsambya pediatric clinic are also both supported by Changing Diabetes in Children (CDiC) programme, which aims to raise awareness about T1D and advocate for access to quality essential healthcare services as well as finding sustainable solutions to strengthen diabetes care. CDiC along with the support of global and local partners, will continue to ensure access to comprehensive high-quality diabetes therapy, by providing insulin, glucometers and glucosticks for children and adolescents living with T1D in our clinics and other low- and middle-income settings.

Therefore, conducting the study at these two sites provided an opportunity to broaden the scope of the data collected especially regarding factors associated. They have also been identified as

centers of excellence in pediatric diabetic care implying that there were systems in place to ease data collection, to follow up patients and to implement any strategies that resulted from the study.

3.3 Study Population

3.3.1 Target population

All children and adolescents with T1D aged from 18 months to 19 years attending the diabetic clinics, at Nsambya Hospital and Mulago National Referral Hospital.

3.3.2 Accessible of the population

All children and adolescents with T1D aged 18 months to 19 years attending the Diabetic clinics during the study period between November 2020 and August 2021.

3.3.3 Study population

All patients aged between 18 months and 19 years diagnosed with T1D (according to the clinic's guidelines on diagnosis of T1D) on treatment and follow-up in the pediatric diabetic clinics who fulfilled the inclusion criteria.

3.3.4 Study Duration

Participants were enrolled twice a week on Tuesday in Mulago Hospital and Friday in Nsambya Hospital until the sample size was achieved, during the period between November 2020 and September 2021.

3.4 Selection Criteria

3.4.1 Inclusion Criteria

- All patients aged between 18 months to 19 years with T1D attending the diabetic clinics of Mulago hospital and St. Francis hospital Nsambya in Kampala, Uganda
- Patients who had had T1D for a minimum duration of 1 year.
- Those whose caretakers consented to be enrolled in the study.

- Those children who assented (a signed form was provided to children between the ages of 8 and 17 who expressed willingness to participate in the research and were cognitively capable of understanding what would be involved).
- Patients aged 18 and 19 years who consented to be enrolled in the study

3.4.2 Exclusion Criteria

- Use of drugs; Angiotensin Converting Enzyme Inhibitors (ACEIs), Angiotensin Receptor Blockers (ARBs) that affect microalbuminuria levels
- Patients with positive leucocytes and nitrites on a urine dipstick.
- Patients with proteinuria (protein result of ≥ + on a urine dipstick)

3.5 Sample Size Estimation

3.5.1 Sample size for prevalence

The **sample size for prevalence** was determined based on a study done by Amal A Al-Eisa in Kuwait in 2017(22). Using the Kish Leslie (1965) formula for calculation proportions in cross sectional studies:

Whereby;

Z = Standard normal value corresponding to 95% Confidence Interval (1.96)

P = the prevalence of the parameter being studied is 0.120

D = Absolute errors between the estimated and true value = 0.05 (5%)

$$N=\frac{0.12(1-0.12)1.96^2}{(0.05)2}$$

N (sample size required) =163

3.5.2 Sample size for factors associated

Sample size for factors associated was based on the previous study by Amal A Al-Eisa in Kuwait in 2017(22). That found out that, compared to normoalbuminuric patients, more female patients were albuminuric (83% vs. 50%).

Assuming α (two-sided) at 95% confident interval with power of 80%, using flees formula for comparing proportion and ratios and substituting the proportions in to Open Epi calculator

Sample Size:X-Sectional study

Two-sided significance level(1-alpha):	95%
Power(1-beta, % chance of detecting):	80%
Ratio of sample size, Unexposed/Exposed:	1
Percent of female with Outcome:	83%
Percent of male with Outcome:	50%
Odds Ratio:	4.9
Risk/Prevalence Ratio:	1.7
Risk/Prevalence difference:	33

	Kelsey	Fleiss	Fleiss with CC
Sample Size – Exposed	33	31	37
Sample Size-Non exposed	33	31	37
Total sample size:	66	62	74

Considering the two sample sizes, the bigger sample size of 163 for prevalence was used. However, putting into consideration 5% for loss to follow up a total of **171 participants, were required for the study.**

3.5.3 Sample Size for prevalence in a Population

Population size (for finite population correction factor or fpc)(*N*): 1000000

Hypothesized % frequency of outcome factor in the population (*p*):12%+/-5.15

Confidence limits, precision as % of 100(absolute +/- %)(*d*): 5.15%

Sample Size(*n*) for Various Confidence Levels

Confidence Level(%)	Sample Size
95%	153
80%	66
90%	108
97%	188
99%	265
99.9%	431
99.99%	603

Equation

Sample size $n = [DEFF*Np(1-p)]/ [(d^2/Z^2_{1-\alpha/2}*(N-1)+p*(1-p)]$

We did not meet the earlier calculated sample size of 171 participants, however we managed to recruit a total of 153 participants giving a precision of 5.15% which is within the acceptable range of 5-15%.

3.6 Study procedure

3.6.1 Sampling Procedure

All children and adolescents diagnosed with T1D aged between 18 months to 19 years, who met the eligibility criteria and attending the pediatric diabetic clinics during the study period were recruited into the study. The patient population attending the diabetic clinics in Nsambya and Mulago hospital is considered to be homogenous (similar characteristics) and both clinics are supported by the CDiC programme. Hence the participants were enrolled by consecutive sampling on the different clinic days until the sample size was achieved. To avoid re-enrolment of study participants, all charts of participants enrolled into the study were color coded. No study participants were enrolled without cross-checking with principal investigator/list of enrolled participants.

3.6.2 Recruitment procedure

The Research assistant screened all the children in the diabetic clinic to identify those who meet the inclusion criteria. Potential participants were given a screening number and subjected to the screening questionnaire and a urine dipstick to determine eligibility for the study.

The urine sample required for the dipstick was collected following clear instructions given to the patient and/or caretaker. The patient was instructed to wash their hands before collecting the sample and to obtain a mid-stream catch of approximately 5 milliliters for the test. A urine dipstick was run on the sample for pH, protein, nitrites, leucocytes, glucose, and ketones. Patients with positive nitrites, leucocytes, or protein ≥+ on dipstick at that point were ineligible for the study and hence were excluded. These patients were screened again for eligibility on their next clinic visit and if found eligible were given an opportunity for enrolment. Information of participants who were screened and found not suitable for the study using urine test were kept confidential in a screening file under lock and key.

For those who passed this stage of urinalysis, consent was sought from caretaker or adolescents aged 18 / 19 years and assent gotten from children aged 8 to 17 years for eligibility. A participant number was then given to those who consented and/or assented to the study. A questionnaire was administered to the participant from the side room in the diabetic clinic in private. After administering the questionnaire, the participant had their blood samples taken off. Recruitment of participants was only in the morning and ended at midday as directed by ISPAD guidelines which insist on morning samples. This was to reduce the false positives that might occur due to orthostatic proteinuria.

3.6.3 History

Detailed demographic data and medical history was obtained during history taking using a structured pretested questionnaire administered by the research assistant or the principal investigator.

3.6.4 Physical Examination

Each study participant underwent a clinical examination. Anthropometric measurements of height and weight of the participants were taken, and the Body Mass Index (BMI) was

calculated. BMI Z score for age was determined at analysis. Weight was measured using a Seca digital weighing scale and height/length was measured with a stadiometer All equipment was calibrated before use to avoid measurement bias.

Blood Pressure (BP) measurement and interpretation was done using an appropriately sized cuff using Manual Welch Allyn pediatric BP cuffs (different sized cuffs were used according to the age of the participant). BP was measured in the right arm unless the child had reported atypical aortic arch anatomy, such as right aortic arch and aortic coarctation or left aortic arch with aberrant right subclavian artery. The bladder length of the cuff was 80%–100% of the circumference of the arm, and the width was at least 40%. The bell of the stethoscope was placed over the brachial artery in the antecubital fossa, and the lower end of the cuff was 2–3 cm above the antecubital fossa. The cuff was inflated to 20–30 mmHg above the point at which the radial pulse disappeared. The first (phase I Korotkoff) and last (phase V Korotkoff) audible sounds were taken as Systolic BP and Diastolic BP respectively. The blood pressure was measured 3 times 15 minutes apart, with the participant in a sitting position with back supported after the child had been resting for about 5 minutes, and recorded. On analysis the average of the 3 blood pressures was calculated. This average measurement was used to determine the child's BP category (normal, elevated BP, stage 1 HTN, or stage 2 HTN) according to the algorithm described in the Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents 2017(64).

Tanner staging was determined on physical examination of the participants using breast size and pubic hair grades for girls, while Prader's orchidometer beads for testicular size and pubic hair grades were used for the boys. A further detailed systemic examination was carried out on all study participants to look for signs of anemia, Diabetic Keto Acidosis (DKA), neuropathy. Those who required urgent attention were immediately attended to by the doctor in the clinic for proper management.

3.6.5 Sample Collection and preparation

Each participant enrolled in the study underwent a finger prick to withdraw blood for random blood glucose measurement as is the norm for all clinic visits. The random blood glucose was

determined using a One touch glucometer(65). Ten milliliters(mls) of blood were then drawn, by venipuncture using plastic disposable syringes under aseptic measures. Two milliliter aliquot was added in the bottle containing anticoagulant Ethylene diamine tetra acetic acid (EDTA) that was used for the determination of glycosylated hemoglobin (HbA1c). The remaining blood was allowed to clot in a red vacutainer at 37°C and serum was separated by centrifugation. The blood samples were analyzed for HbA1c, using the turbidimetric inhibition immunoassay method(66). The samples were also analyzed for serum urease using the Berthelot Reaction and serum creatinine using the Jaffe's reaction(67, 68).

The urine sample provided earlier, for the dipstick, was stored at 4^{o}C for a duration of less than 6 to 8 hours to allow transportation of samples to the laboratory for analysis. Urine sample was kept at room temperature for 15 minutes to allow thawing before tests were performed. Urine albumin excretion was determined using the immunoturbidimetric method(11), while urine creatinine concentration was measured by standard laboratory methods using the Jaffe's reaction(69).

Blood and urine samples were analyzed at Mulago National Referral Hospital biochemistry and hematology laboratory using Roche/Hitachi Cobas C systems c311/501 analyzer (USA). The kits, reagents, calibrators and controls to be used were obtained as Cobas C reagent packs from the manufacturer. Mulago National Referral Hospital laboratory is a star 3 laboratory by South African National Accreditation System (SANAS) and the samples were analyzed by a senior laboratory technician and laboratory assistant with 12 and 14 years of experience respectively.

Microalbuminuria, in milligrams/gram, was determined by the ratio of urine albumin to urine creatinine concentration and was computed by the equation below(70).

$$\frac{\text{Urine albumin (mg/dl)}}{\text{Urine creatinine (g/dl)}}$$

The albumin/creatinine ratio (ACR) of 30 to 300 mg/g in males and 42 to 300 mg/g in females was considered abnormal – suspected Microalbuminuria.

Confirmed Microalbuminuria was defined using ISPAD guidelines with a presence of 2 urine tests showing an elevated ACR of 30 to 300 mg/g in males and 42 to 300 mg/g in females within the 3-month period.

Estimated Glomerular filtration rate (eGFR) was calculated using the Schwartz formula, stated below, in milliliters per minute per 1.73 m^2(71).

Estimated Glomerular filtration rate = k * Height(cm) / Serum creatinine (mg/dl)

The value of k is 0.45 for term infants throughout the first year of life, 0.55 for children and adolescent girls, and 0.7 for adolescent boys, using Jaffe creatinine methodology(71). Glomerular hyperfiltration was determined from these findings and was defined as eGFR>120 ml/ min/1.73m^2 in children <12 years of age and >130 ml/ min/1.73m^2 in children older than 12 years.

3.6.6 Confirmation of Microalbuminuria

All participants were provided with their results from the blood and urine tests and only participants with an albumin/creatinine ratio (ACR) of 30 to 300 mg/g in males and 42 to 300 mg/g in females were tested again within a 3-month period for confirmation of microalbuminuria. They were required to only provide another sample of urine to repeat the urine dipstick, urine creatinine and urine albumin to assess microalbuminuria at these different points for the purpose of confirmation of microalbuminuria according to current ISPAD guidelines(21). **Microalbuminuria was confirmed with a presence of 2 urine tests showing an elevated ACR of 30 to 300 mg/g in males and 42 to 300 mg/g in females within the 3-month period.** Phone calls were made to remind participants of their scheduled visit 2 days before the visit. And incase participants did not show up for scheduled visit, another phone call was made. A patient was considered lost to follow up, if after 2 phone calls there was no response and if the participant did not return to the clinic within 3 months of the initial urine test.

3.6.7 Routine Care

All participants received standard care provided by the pediatric diabetic clinic team according to the protocols present. Those who required further care, like intravenous fluid resuscitation due to DKA or hypoglycemia or admission, management was discussed with the pediatrician in the clinic. Any patient found to have microalbuminuria was referred for further assessment by the pediatric nephrologist.

3.7 Study variables

3.7.1 Independent variable

Independent variables included:

Socio-demography: Age, sex, Age at diagnosis, Relationship of the child with the caretaker, Level of education with the caretaker, Occupation of the caretaker, socioeconomic status of the participant.

Diabetes history: Initial Diagnosis of T1D, Insulin type, no of injections per day, doses of Insulin in IU per kilogram per day, number of times dose of insulin had been increased in the previous year, number of admissions in the previous year, infections of injection sites, number of times child had needed antibiotics or intravenous fluid resuscitation in the previous year, possession of a glucometer and how often they tested their glucose.

Nutritional Factors: Dietary intake, Type of food

Laboratory factors: HbA1c level at diagnosis, Previous HbA1c readings in the last one year (if available), random and fasting blood glucose levels, hemoglobin level.

Other factors; age of pubertal onset, and other chronic illnesses.

3.7.2 Dependent variable

This was a dichotomous variable of microalbuminuria and no microalbuminuria.

3.8 Data collection,

Data was collected from children aged 18 months to 19 years with T1D seeking care at pediatric diabetic clinics of Mulago National Referral and Nsambya Hospitals. All children with T1D were identified and introduced to the research assistant who then informed the child and/or caretaker about the study. The data was collected twice a week because the clinics only operate on Tuesday in Mulago Hospital and Friday in Nsambya Hospital. The interview was conducted in English or Luganda, whichever was best understood by the caretaker/participant in a separate room by the trained research assistant. The responses were recorded on a data collection tool. Each questionnaire took approximately 15 to 45 minutes to complete.

3.9 Quality control/ assurance

The Data was collected by the researcher with support of three research assistants. The research assistants who were three diploma and one degree nurse with 3- 5 years' experience in the

diabetic clinic were trained for three days about the proposal, data collection tool, standard operation procedure of the protocol, human subject protection, ensuring privacy and confidentiality. Quality of the data collected was maintained throughout the study by direct supervision of the process by principal investigator. Five questionnaires were pre-tested on the clinic staff before study period by the principal investigator. Quality of data collected was ensured by cross-checking data at the end of each interview by the researcher. Participants were asked about symptoms of a urinary tract infection at two points within the study; at screening but also at data collection to ensure quality of the data obtained since microalbuminuria was our major outcome.

3.9.2 Data management

The filled questionnaires by researcher assistants were cross-checked immediately after filling for completeness on a daily basis by the principal investigator.

All questionnaires coded were entered in Epidata version 3.1 computer software and, double entry of the data was conducted by the researcher to minimize errors of entry. Data entered was exported to STATA version 14 for cleaning and analysis. Electronic data was backed up in a password protected computer and was only accessible by the principal investigator. All data collection tools and consents were kept in a cabinet under key and lock and only accessible by the principal investigator.

Collected data was manually transferred into electronic form using Microsoft ™ Excel software package which was then checked for missing variables and duplication by comparing the data on the CRF and the electronic form by 2 research assistants. Duplicate finder and Sort and filter functions in Microsoft Excel were used to identify any missing values and duplicates. Duplicates were removed and comparison of hard copy and electronic versions were done for missing variables.

3.9.3 Data analysis

Data from Epidata was exported to STATA for cleaning and analyzed with the help of a Bio-statistician. Descriptive statistics for continuous variables were presented in terms of means, and standard deviation if normally distributed otherwise medians and interquartile range. Categorical

variables were presented in terms frequencies and proportion.To determine factors associated with microalbuminuria in children with Type 1 DM attending diabetic clinic in the Mulago Hospital series of analyses were performed at bivariate and multivariate levels using logistic regression.

At bivariate analysis, logistic regression was performed to assess for association between the independent variables and the presence of microalbuminuria in children with crude odds ratios at 95% confidence level. Variables that were significant at bivariate were included in the multivariate analysis one at a time removing and adding until the stable model was achieved, variables with p values <0.05 were considered to be independently and statistically associated with the microalbuminuria.

3.10 Ethical considerations

Permission to carry out the study was obtained from the Makerere University School of Medicine Research and Ethics Committee (SOMREC) and administrative clearance was sought from Mulago National Referral Hospital and St. Francis Hospital Nsambya. Consent forms were translated into Luganda. Caretaker written informed consent and assent (for children aged 8-17) was obtained for the eligible children. Written Informed consent was also obtained from adolescents aged 18 and 19 years. Participants were given an identifying number for the study that aimed at identifying them by numbers and not their real names as a matter of ensuring their privacy through anonymity. All participants found to have significant microalbuminuria or kidney function derangements were linked to a pediatric nephrologist at Mulago hospital.

3.11 Results dissemination

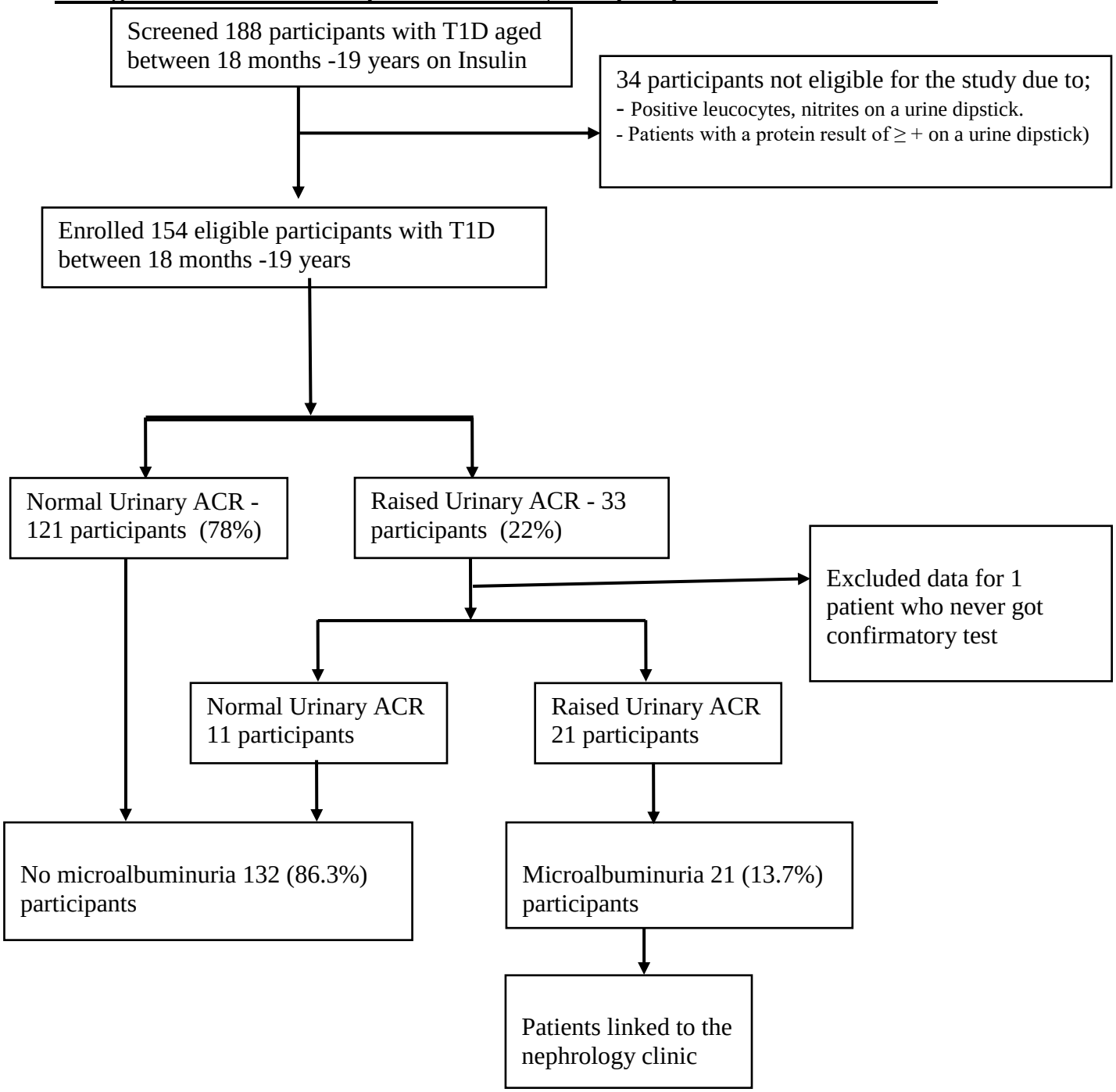
Dissemination of research involves communicating scientific results, methods and values from specialized research field to people outside the discipline. The findings of the study will be presented in different fora. The final copy of the report shall be made available to the Department of Pediatrics and Child Health, Makerere University, a report will be published as a journal article in a peer reviewed journal and to the College of Health Sciences Library in Makerere University. A write-up of the study results will be produced for different presentations at conferences, both at local and international levels.

CHAPTER FOUR; RESULTS

4.1 Study Profile

A total of 188 children with T1D were screened (Appendix1) for the study between November 2020 and September 2021. 154 of these were recruited however one participant's data was excluded since patient was lost to follow up **hence data for 153 participants was analyzed.** The details of enrollment are shown in the study profile below.

Figure 2 **Study Profile of children and adolescents with T1D aged 18 months to 19 years in Mulago National referral hospital and Nsambya Hospital pediatric diabetic clinics.**



On the initial visit, 32 participants had a raised urinary albumin to creatinine ratio (ACR) between 30 to 300 mg/g in males and between 42 to 300 mg/g in females. The 32 participants who had microalbuminuria on this visit were retested within 3 months and microalbuminuria was diagnosed based on presence of 2 tests with raised urinary ACR as per ISPAD guidelines 2018 . **Of the participants recruited, the total number of participants with microalbuminuria was 21.**

4.2 Patient Social demographic characteristics.

From a total of 153 participants whose data was analyzed, **84 participants (55%) were from St. Francis Hospital Nsambya while 69 participants (45%) were from Mulago National Referral Hospital Pediatric diabetic clinics.** Among the total study population, 83 (54.2%) participants were males. The median age of participants at the time of study was 8.4 years (6.1 to 12.1 years) and the youngest participant was 3 years, 7 months old and only 2 participants were below age 5 years. There were no children who were smoking and only one adolescent who was drinking alcohol among the study participants. The rest of the patient demographic characteristics are displayed in Table 1 below.

Table 1**: Sociodemographic characteristics of participants and caregivers of participants with T1D aged 18 months -19 years attending the pediatric diabetic clinics at Mulago National Referral and Nsambya Hospitals**.

Variables		Total **(n=153)**	No microalbuminuria **(n=132)**	Microalbuminuria **(n=21)**
		Frequency (%)	**Frequency (%)**	**Frequency (%)**
Age (years)	<10	27 (17.6)	25 (18.9)	2 (9.5)
	10-19	126(82.3)	107(81.1)	19(90.5)
Sex	Female	70 (45.8)	58 (43.9)	12(57.1)
	Male	83 (54.2)	74(56.1)	9(42.9)
Level of education of the child/adolescent	Not in school	12 (7.8)	10 (7.5)	2(9.5)
	Primary	76 (49.6)	69(52.2)	7(33.3)
	Secondary	50 (32.7)	41(31.1)	9(42.9)
	Tertiary	15 (9.8)	12(9.1)	3(14.3)
Family history of hypertension	Yes	36 (23.5)	31(23.5)	5(23.8)
	No	117 (76.5)	101(76.5)	16(76.2)
Family history of kidney disease	Yes	4 (2.6)	4(3.0)	0(00)
	No	149 (97.4)	128(97.0)	21(100)
Caretaker level of education	Primary	34(22.2)	31(23.5)	3(14.3)
	Secondary	33(21.6)	28(21.2)	5(23.8)
	Tertiary	86(56.2)	73(55.3)	13(61.9)
Caretaker employment status	Employed	53(34.6)	47(35.6)	6(28.6)
	Business	56(36.6)	46(34.9)	10(47.6)
	Unemployed	44(28.8)	39(29.5)	5(23.8)

4.3 Clinical and disease related Participant characteristics

The mean age at diagnosis of T1D was 8.9±3.8 years with a median duration of disease of T1D being 4.35 (2.65 to 7.95) years. Majority of the participants (92%) had T1D for less than or equal to 5 years while the rest had it for more than 5 years. ISPAD guidelines recommends that children and adolescents have an HbA1c value recorded at diagnosis and every 3 months after that. However, in our study only 76 of the participants had an HbA1c recorded on diagnosis. Additionally, only 120 (78%) participants reported having an HbA1c sample taken off, and also had this value recorded in their records, in the 3 months prior to enrollment in the study. All participants had records of home glucose monitoring values in the 3 preceding months before recruitment however only 147(96%) reported having working glucometers at the time of recruitment. The rest of the patient characteristics are listed in table 2.

Table 2; **Diabetic characteristics of 153 children with Type 1 Diabetes Mellitus aged 18 months to 19 years attending the pediatric diabetic clinic at Mulago and Nsambya Hospitals.**

Variables		Total **(n =153)**	No microalbuminuria **(n=132)**	Microalbuminuria **(n=21)**
		Frequency (%)	**Frequency (%)**	**Frequency (%)**
Mean Age at diagnosis of Type 1 DM (years) (mean, SD)		8.9±3.8	8.7±3.9	10.3±3.9
Duration of Type 1 DM	≤5years	92 (60.1)	75 (56.8)	17 (80.9)
	>5years	61 (39.9)	57 (43.2)	4 (19.1)
Presence of DKA at diagnosis*	Yes	89 (58.2)	80 (60.6)	9 (42.9)
	No	64 (41.8)	52 (39.4)	12 (57.1)
Insulin dose (IU per kg)	<0.5	11(7.2)	9(6.8)	2(9.5)
	0.5-1	118(77.1)	104(78.8)	14(66.7)
	>1	24(15.7)	19(14.4)	5(23.8)
Insulin insecurity**	Did not self-ration	137 (89.5)	117 (88.6)	20 (95.2)
	Self-rationed	16 (10.5)	15 (11.4)	1 (4.7)
Number of insulin doses a day	≤ 2 doses	23 (15.0)	20 (15.2)	3 (14.3)
	≥ 3 doses	130 (85.0)	112(84.9)	18(85.7)
Having a glucometer at home	Yes	147 (96.1)	127 (96.2)	20 (95.3)
	No	6 (3.9)	5 (3.8)	1 (4.7)
Glucose strips insecurity***	Did not ration	39 (25.5)	32 (24.2)	7 (33.3)
	Rationed	114 (74.5)	100 (75.3)	14 (66.7)
Sick day visits******	None	90 (58.8)	81 (61.4)	9 (42.9)
	Yes	63 (41.2)	51 (38.6)	12 (57.1)
Episodes of hypoglycemia in the preceding 3 months*******	None	98 (64.1)	86 (65.1)	12 (57.1)
	Yes	55 (35.9)	46 (34.9)	9 (42.9)
Hospitalization in the previous year	None	132 (86.3)	119 (90.2)	13 (61.9)
	Yes	21 (13.7)	13 (9.8)	8 (38.1)

***The presence of DKA at diagnosis was determined from patient review of the participants file in the Diabetic clinic

**Insulin insecurity; a participant's report of having to use less insulin for fear of it running out before the next clinic date.

***Glucose strips insecurity; a participant's report of having to ration glucose strips for fear of them running out before the next clinic date.

****Sick day visits were assessed by recording number of visits over the three month period prior to recruitment in the study.

*****The episodes of hypoglycemia in the preceding 3 months were obtained by looking through the participants glucometer readings (RBS < 3mmol/l) while at home.

4.4 Participant physical examination and laboratory findings.

Table 3**; Participant physical examination and laboratory findings of 153 participants with T1D aged 18 months to 19 years attending the pediatric diabetic clinic at Mulago and Nsambya Hospitals.**

Variables		Total **(n=153)**	No microalbuminuria **(n=132)**	Microalbuminuria **(n=21)**
		Frequency (%)	**Frequency (%)**	**Frequency (%)**
Tanner stage*	1	54(35.3)	50(37.8)	4(19.1)
	2	11(7.2)	10(7.6)	1(4.8)
	3	26(16.9)	22(16.7)	4(19.1)
	4	35(22.8)	27(20.5)	8(38.1)
	5	27(17.8)	23(17.4)	4(19.1)
Nutritional status	Normal Weight for Height ≥ –2 to ≤ +2 Z score		2(1.5)	
	Severe thinness BMI <-3 Z score	7 (4.6)	3(2.27)	4 (19)
	Moderate thinness BMI –3 Z score and – 2	7 (4.6)	6(4.5)	1(4.7)
	Normal BMI ≥ –2 to ≤ +2 Z score	128 (83.7)	110(83.3)	16(76.1)
	Overweight BMI 3 and -2 Z score	7 (4.6)	7(5.3)	
	Obese BMI > 3 Z score	4 (2.6)	3(2.27)	1 (4.7)
Blood pressure	No hypertension	124(81.1)	112(84.9)	12(57.1)
	Hypertension**	29(18.9)	20(15.2)	9(42.9)
HbA1c (%) **(mean, SD)**		11.2±2.5	11.1±2.4	12.4±3.2
Creatinine (mg/dl) **(mean, SD)**		0.86±0.4	0.86±0.3	0.86±0.4
Urea (mmol/l) **(mean, SD)**		3.5±1.2	3.6±1.2	3.2±1.2
eGFR (ml/min/1.73 m^2)		127±65.9	127.9±68.2	124.8±51.1

* Tanner staging was determined on physical examination of the participants using breast size and pubic hair grades for girls, while Prader's orchidometer beads for testicular size and pubic hair grades were used for the boys.
Hypertension was defined as both Stage 1 and Stage 2 Hypertension according to the Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents 2017.**

Majority of the microalbuminuria participants were in Tanner stage 4 and 5 and a higher mean HbA1c of 12.4±3.2% was recorded among participants with microalbuminuria compared to those without microalbuminuria. The mean serum creatinine was 0.86±0.44 mg/dl and mean serum urea was 3.5±1.2 mmol/l. The mean estimated Glomerular filtration rate(eGFR) of the study population was 127.7 ± 65.9 ml/min/1.73 m^2 and hyper filtration was reported in 38.6% of the participants. Regarding nutritional status, there were only 2 participants who were below the age of 5 years and hence a weight for height Z score was used to determine their nutritional status. The rest of the findings are as described in Table 3 above.

4.5 Prevalence of Microalbuminuria

The Prevalence of microalbuminuria in this study population was 13.7 % (95% CI: 9.1 – 20.2%) as shown in Figure 3 below. Microalbuminuria was more common among middle adolescence (aged 15 – 17 years) with a percentage of 38.1%, followed by late adolescents (18-19 years) at 33.3%, early adolescents (10 – 14 years) at 19.1% and was least common among children <10 years at 9.52%.

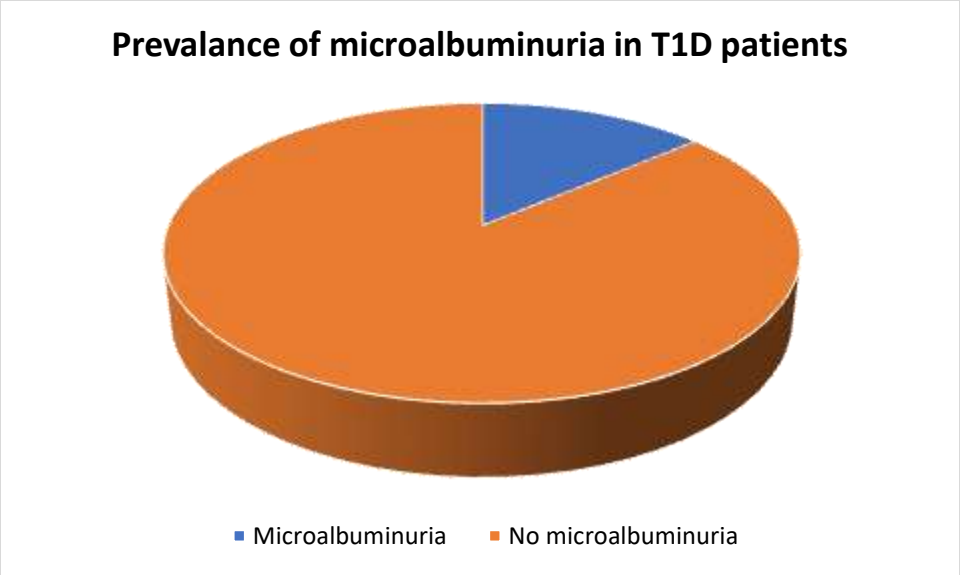


Figure 3 **Pie chart showing the prevalence of microalbuminuria among children and adolescents 18 months to 19 years with Type 1 Diabetes Mellitus attending the pediatric diabetic clinic at Mulago and Nsambya Hospitals.**

4.6 Gender distribution of the study participants with and without microalbuminuria.

Among the participants that had microalbuminuria, female participants had a higher prevalence of microalbuminuria of 57.1% compared to males as shown in figure 4 below;

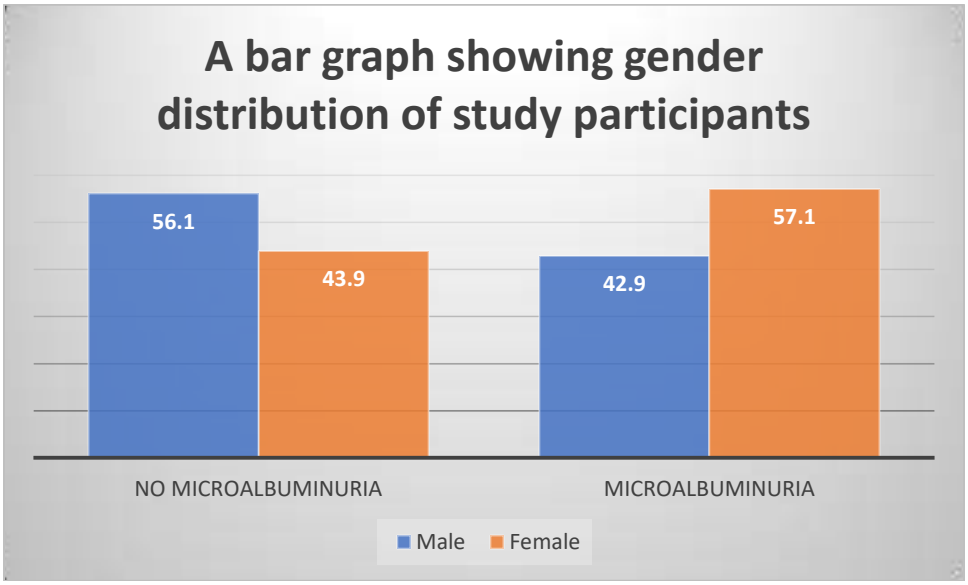


Figure 4; A Bar graph representing gender distribution of the study participants with microalbuminuria and those without microalbuminuria.

4.7 Bivariable analysis for factors associated with microalbuminuria in Type 1 Diabetes Mellitus.

At bivariate analysis, duration of T1D less than 5 years (cOR 3.23; 95% CI, 1.03, 10.12**)**, hospitalization in the previous year (cOR 5.63; 95% CI 1.97,16.10) and elevated blood pressure (cOR 4.20; 95% CI 1.57, 11.26) and HbA1c (cOR 1.22; 95% CI 1.02, 1.45) were significantly associated with microalbuminuria in T1D as shown in table 4 below.

Table 4; Bivariate analysis of participant factors associated with microalbuminuria.

Variables		Microalbuminuria		CoR, 95% CI	P value
		NO (n=132) (f, %)	YES (n=21) (f, %)		
Age (years)	<10	25(18.9)	2(9.5)	1.00	
	10-19	126(82.3)	107(81.1)	3.24(0.61,17.09)	0.166
Sex	Male	74(56.1)	9(42.9)	1.00	
	Female	58(43.9)	12(57.1)	1.70(0.67-4.31)	0.263
Mean age at diagnosis of T1D		8.7±3.9	10.3±3.9	1.11(0.98-1.25)	0.088
Duration of Type 1 DM	>5years	57(43.2)	4(19.1)	1.00	
	≤5years	75(56.8)	17(80.9)	**3.23(1.03-10.12)**	**0.044**
Presence of DKA at diagnosis	Yes	80(60.6)	9(42.9)	2.05(0.81,5.21)	0.131
	No	52(39.4)	12(57.1)	1.00	
Episodes of hypoglycemia* in the preceding 3 months	None	86(65.1)	12(57.1)	1.00	
	Yes	46(34.9)	9(42.9)	1.40(0.55-3.57)	0.479
Insulin (IU per kg)	<0.5	9(6.8)	2(9.5)	1.00	
	0.5-1	104(78.8)	14(66.7)	0.61(0.12,3.09)	0.547
	>1	19(14.4)	5(23.8)	1.18(0.12,7.32)	0.856
Number of insulin doses a day	≤ 2 doses	20 (15.2)	3 (14.3)	1.00	
	≥ 3 doses	112(84.9)	18(85.7)	1.07(0.29-3.98)	0.918
Glucose strips insecurity	Did not self-ration	32(24.2)	7(33.3)	1.00	
	Did self-rationing	100(75.3)	14(66.7)	0.64(0.24-1.72)	0.377
Hospitalization in the previous year	None	119(90.2)	13(61.9)	1.00	
	Yes	13(9.8)	8(38.1)	**5.63(1.97-16.10)**	**0.001**
Blood Pressure category	No Hypertension	112(84.9)	12(57.1)	1.00	
	Hypertension**	20(15.2)	9(42.9)	**4.20(1.57-11.26)**	**0.004**
HbA1c (%) (mean, SD)		11.1±2.4	12.4±3.2	**1.22(1.02-1.45)**	**0.024**
Tanner stage	1&2	60(45.5)	5(23.8)	1.00	
	3-5	72(54.5)	16(76.2)	2.67(0.92,7.70)	0.070
Creatinine (mg/dl) (mean, SD)		0.86±0.4	0.86±0.3	2.05(0.81,5.21)	0.999
Urea (mmol/l) (mean, SD)		3.6±1.2	3.2±1.2	1.34(0.78-2.31)	0.146
eGFR (ml/min/1.73 m^2)		127.9±68.2	124.8±51.1	0.99(0.99-1.01)	0.844

*****Hypoglycemia was defined as an RBS of <3mmol/l

Hypertension was defined as Stage 1 and Stage 2 Hypertension according to the Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents 2017.**

4.8 Factors associated with microalbuminuria at multivariate analysis

Duration of T1D less than 5 years (aOR **27.44, 95% CI (3.32,226.77)** hospitalization in the previous year (aOR **5.39, 95% CI (1.21-23.94)**and elevated blood pressure (aOR **19.12, 95% CI (3.39,107.83)**) and HbA1c (aOR **1.41, 955 CI (1.12-1.783)** were significantly associated with microalbuminuria in T1D as shown in the table 5 below.

Table 5; **Multivariate analysis of independent association with Microalbuminuria in Type 1 Diabetes Mellitus.**

Variables		CoR, 95% CI	P value	AoR 95% CI	P value
Age	<10	1.00		1.00	
	10-19	3.24(0.61,17.09)	0.166	6.22(0.87,52.23)	0.069
Sex	Male	1.00		1.00	
	Female	1.70(0.67-4.31)	0.263	3.82(0.99-14.74)	0.051
Age at diagnosis of Type 1 DM		1.11(0.98-1.25)	0.088		
Duration of Type 1 DM	>5 years	1.00		1.00	
	≤5 years	3.23(1.03-10.12)	0.044	**27.44(3.32,226.77)**	**0.002**
Presence of DKA at diagnosis	No	1.00		1.00	
	Yes	2.05(0.81,5.21)	0.131	2.85(0.81,10.09)	0.14
Sick days visit	None	1.00			
	Yes	2.12(0.83-5.38)	0.115	1.09(0.32,3.65)	0.895
Hospitalization in the previous year	None	1.00		1.00	
	Yes	5.63(1.97-16.10)	0.001	**5.39(1.21-23.94)**	**0.027**
Pressure category	No Hypertension	1.00		1.00	
	Hypertension	4.20(1.57-11.26)	0.004	**19.12(3.39,107.83)**	**0.001**
HbA1c (%)		1.22(1.02-1.45)	0.024	**1.41(1.12-1.783)**	**0.003**

CHAPTER FIVE; DISCUSSION

This was a crossectional study that aimed to determine the prevalence and factors associated with microalbuminuria in children and adolescents with T1D attending the pediatric diabetic clinics in both Mulago and Nsambya Hospitals.

5.1 Prevalence of Microalbuminuria

In this study, we found a high prevalence of microalbuminuria, that is, 13.7 %, among the children and adolescents with T1D attending the pediatric diabetic clinics of Mulago and Nsambya Hospitals. The high prevalence identified may be due to increased genetic predisposition to kidney disease among African patients, or barriers to accessing care, leading to late diagnosis and poor glycemic control, which can all result in microalbuminuria. These results indicate that many children and adolescents in our setting have undiagnosed diabetic nephropathy and are at risk of ESKD later in life.

Despite the prevalence in this study being notably high, 10 years later, the prevalence of microalbuminuria has reduced by more than 2/3 in Uganda and yet the glycemic control among the children has hardly changed(20). The difference in prevalence could be due to methodological limitations which involved the use of only one urine sample to determine microalbuminuria which would result in a high number of false positives hence an over estimation of microalbuminuria(20). Additionally, the availability of insulin, as well as glucose monitoring has improved, and these may also be some of the reasons for the lower prevalence in our study as compared to Ofumbi et al in 2009 who found a prevalence of 62.7%.

The prevalence in this study is slightly lower than that reported in many African countries including Tanzania, where 29% of 99 children with a mean diabetes duration of only 5 years had microalbuminuria (17, 48-50, 72). Recent evidence in Botswana on 127 children and young people also reported a prevalence of microalbuminuria of 28.3% (49), as well as in Kinshasa were a prevalence of 21% was found.

It is notable that various study methodologies were employed in previous studies published from other African countries which could have contributed to the difference in results. The study in

Botswana used retrospective data which has limitations regarding data completeness and young adults were included in this study increasing the likelihood of microalbuminuria (49). The Tanzanian study used different methods for testing for microalbuminuria as compared to this study that used urine ACR(72). It is also noteworthy that ACR is more specific than the microalbumin agglutinin test used in that study hence reducing the chances of overestimating the microalbuminuria in our study population. Nigeria reported a higher prevalence of microalbuminuria of 60% in 20 patients with Type 1 diabetes receiving care in University of Port Harcourt teaching hospital in 2020(48). The Nigerian study most likely over diagnosed microalbuminuria but they also had a very small sample size of only 20 participants which could provide an explanation for the results seen in this study.

With a prevalence rate of microalbuminuria established to be 13.7%, it was far higher than that which was reported in higher income countries. For example, in the USA in 2015, a rate of 3.3% was registered, 5% in UK and 3.3% in German diabetic children (14-16). In higher income countries children and adolescents with T1D have more comprehensive DM care with more access to insulin, glucose monitoring, monitoring of complications and diabetes education with better glycemic control as compared to the children and adolescents in African countries resulting in the lower levels of microalbuminuria (14-16).

5.2 Factors associated with microalbuminuria

The factors that were significantly associated with microalbuminuria in T1D in this study included, duration of treatment less than 5 years, hospitalization in the previous year, elevated blood pressure and elevated HbA1c

5.2.1 Duration of T1D Mellitus less than 5 years.

Participants who had been diagnosed with T1D for less than 5 years had a 27-times higher chance of microalbuminuria; the confidence interval for this finding is however wide denoting a lower precision. This is a peculiar finding because the ISPAD and ADA guidelines recommend screening for microalbuminuria in childhood diabetes especially type 1 after 5 years of the disease process, when puberty starts, or at age 10 years because microalbuminuria rarely occurs shortly after the disease is established(24). The mean age at diagnosis of T1D among participants

with microalbuminuria was slightly higher at 10.3±3.9 years (around puberty) compared to the non microalbuminuric group at 8.7±3.9 years. Hence factors associated with puberty could be at play increasing the chance of having microalbuminuria among this group hence explaining this finding in our study.

Similar findings have been seen in other studies including; one in Kuwait, [where 65% of patients with diabetic nephropathy had T1D for less than 5 years(22),] Rwanda, Tanzania(4, 19) and Nigeria(48). Factors hypothesized to be driving this finding, especially among African children, is the increased genetic propensity for kidney disease among Africans. Genomic regions underlying nephropathy appear to be more race-specific, notably between African and European Americans (73). Moreover, genes which are 'protective' in European Americans may not exert this effect in Africans(19). This raises the need for early and more frequent screening for microalbuminuria irrespective of conventional recommended durations of the child having had T1D especially in African children. However, since 30 - 40% of microalbuminuria resolves spontaneously(28), longer follow-up of these patients is necessary to document regression or progression of microalbuminuria.

5.2.2 Elevated HbA1c

The mean HbA1c of our study sample was 11.2±2.5% and is far higher than the target set by ISPAD guidelines. An even higher mean HbA1c of 12.4±3.2% was found among the participants with microalbuminuria hence for every 1% increase in HbA1c above the mean, there was a 1.4 times chance of having microalbuminuria (p=0.003). Chronic exposure of the glomerular endothelium to hyperglycemia results in endothelial dysfunction thus increasing glomerular permeability to albumin through the glomerular filtration barrier hence microalbuminuria(74).

Multiple studies in several countries have confirmed that a higher HbA_{1c} is an independent risk factor for diabetes complications: microalbuminuria being one of them(4, 15, 16, 19, 74, 75). ISPAD guidelines therefore recommend a target HbA1c of <53 mmol/mol (<7.0%) for children, adolescents, and young adults with diabetes who have access to comprehensive care and less than 7.5% with limited care (24). Achievement of target glycemic control will reduce the risk for onset and progression of diabetes vascular complications (24). In our study 97% of the

participants had an HbA1c above 7.5% and since this HbA_{1c} is far from the target set by the ISPAD guidelines, the children and adolescents are predisposed to other microvascular complications like nephropathy, retinopathy and so priority needs to be given to addressing glycemic control since this is a modifiable risk factor.

5.2.3 Hypertension

This study found that increases in blood pressure, among children and adolescents had a 19-fold risk of development of microalbuminuria. Hypertension and microalbuminuria have been shown by various studies to co-exist, it's unclear whether preexisting hypertension contributes to development of microalbuminuria(16, 49, 76). Patients with microalbuminuria also have significant abnormalities in the kidney, including in glomeruli predisposing them to glomerular and systemic hypertension which are crucial in the progression of diabetic kidney disease (77, 78). These findings are consistent with studies done in Germany, Rwanda and Denmark which suggested that microalbuminuria was more common among young adults with poor glycemic control and elevated blood pressure(16, 17, 76).

Previous studies have shown that a familial predisposition to hypertension increases the risk of developing diabetic nephropathy(56). This was not found to be significant in this study and the difference could probably be explained by response and recall bias among the participants since we did not actually measure blood pressure for any of the family members.

High blood pressure and alterations in the circadian BP rhythm have been associated with the risk of developing nephropathy and retinopathy in youth with T1D (78). An increase in nocturnal blood pressure has been noted to result in progression to microalbuminuria in T1D(78). Such changes in systemic blood pressure may be small, which makes detection difficult unless validated, precise methods are used, such as ambulatory blood pressure measurements over 24 hours(76). Additionally, ambulatory blood pressure measurements are also used in measuring the presence of the white coat hypertension (an elevation of clinic pressure with a normal daytime ambulatory profile)(55). Unfortunately, we did not use ambulatory blood pressure measurements which could have resulted in an over estimation of hypertension in our study.

5.2.4. Hospitalization in the previous year

Microalbuminuria was five times more likely to occur among children and adolescents who had had a hospital admission in the previous year. This factor has not been found to be significantly associated with microalbuminuria in other studies. A possible explanation for this association in our study is that children with multiple hospitalizations are more likely to have poor glycemic control which is already a risk factor for microalbuminuria.

5.2.5 Hyperfiltration

The estimated glomerular filtration rate is hypothesized to be a precursor of intra-glomerular hypertension preceding microalbuminuria by many years. This is the earliest stage of diabetic nephropathy and is characterized by glomerular hypertrophy, hyper filtration, and hyper perfusion(10, 24). Hyperfiltration in this study was defined as eGFR>120 ml/ min/1.73m^2 in children <12 years of age and >130 ml/ min/1.73m^2 in children older than 12 years(22, 79). A recent meta-analysis of ten type 1 diabetes studies concluded that the presence of hyperfiltration at baseline more than doubled the risk of developing micro- or macroalbuminuria at follow-up(80, 81). The traditional and most accurate method for direct measurement of GFR is the constant infusion technique using a marker such as inulin (81). This relies on achieving a stable plasma level of a marker that is cleared from the circulation only by the kidney. In addition, kidney handling of the marker must be by glomerular filtration without any contribution by tubular reabsorption or secretion. GFR has been measured with filtration markers such as iohexol or isotopically labelled markers such as iothalamate, ethylene diamine tetracetic (EDTA) acid and dithiopentaacetic acid (DTPA), using a single injection technique since these are more feasible for research settings especially in larger studies. Creatinine based methods can be used but they tend to underestimate GFR in the hyperfiltration range(81).

Apart from hyperglycaemia, other factors influencing the prevalence of hyperfiltration in type 1 diabetes include the level of albuminuria, duration of diabetes, younger age of disease onset and pubertal status(81). In a prospective cohort study done among patients with Type 1 Diabetes, the probability of having hyperfiltration at 5 years' duration was related to puberty and poor glycemic control. eGFR in this study was measured using plasma clearance of Inutest using a

single intravenous bolus and mean GFR in the microalbuminuric group was 166.8 ml/ min/1.73m^2(82).

Hyperfiltration was at 38.6% in our study sample and hence was not common. Commonly reported rates in studies are 40% -60% (22, 81). However, it has been seen to be much higher in other studies like in Kuwait at 87% (21). The low value in our study sample could be explained by use of creatinine in calculating eGFR causing an underestimate of the glomerular function. Ideally, use of isotopically labelled markers such as iothalamate, ethylene diamine tetracetic acid or endogenous filtration markers such as cystatin -C would have been a better marker of estimating glomerular filtration rate and hence baseline kidney function.

5.3 Strengths of the study

A major strength of this study is the method used to diagnose microalbuminuria, which was use of 2 samples with raised ACR over a 3-month period as recommended by ISPAD guidelines to confirm the diagnosis of microalbuminuria. This helped to reduce the number of false positives hence increasing the accuracy of the results. This study was also done in two study sites in Kampala; hence the results are more representative of the country's population. The results are also in keeping with the other resource limited settings.

5.4 Limitations of the study

Due to the COVID -19 restrictions, we did not meet the study sample size calculated which was 163 participants, but with the current sample size of 153 participants (93.8% of the initial calculated sample size), **the study had a precision of 5.15% which is within the acceptable range of 5-15%.**

The presence of hypertension could have been overestimated as the study did not schedule the participants for a repeat blood pressure check on another visit during the study. We also did not perform ambulatory blood pressure monitoring to eliminate the possibility of white coat hypertension.

CHAPTER SIX; CONCLUSION AND RECOMMENDATIONS

6.1 Conclusions

- Our study in Mulago and Nsambya Hospital's pediatric diabetic clinics, identified a high prevalence of microalbuminuria in children and adolescents of 13.7% which is slightly lower than in other African countries but much higher than most developed countries.
- Children and adolescents who had been diagnosed with Diabetes for less than 5 years, had one or more hospitalizations in the previous year, hypertension and elevated HbA1c were more likely to have microalbuminuria.

6.2 Recommendations

- As clinicians we should be more vigilant with children and adolescents with T1D who have been admitted on the ward with any complication of T1D. As part of their workup, they should be investigated for microalbuminuria and followed up more strictly in the clinic on discharge.
- Early and more frequent screening for microalbuminuria irrespective duration of T1D should be done especially in Ugandan children despite the ISPAD guidelines.
- Elevated HbA1c in our setting puts our patients at a higher risk of microalbuminuria compared to other children and adolescents in the developed world. Hence clinicians caring for children and adolescents with T1D should ensure strict glycemic control since this is a modifiable risk factor.
- Children and adolescents need to have their Blood pressures measured at every visit and blood pressures values interpreted according to Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents 2017 by the triage team in diabetic clinics. Patients with elevated, Stage 1 and Stage 2 hypertension should be promptly screened for microalbuminuria.

REFERENCES

1. Juma PA, Mohamed SF, Mwagomba BLM, Ndinda C, Mapa-Tassou C, Oluwasanu M, et al. Non-communicable disease prevention policy process in five African countries authors. BMC public health. 2018;18(1):961.
2. (IDF). IDF. International Diabetes Federation (IDF) Atlas.; 2019.
3. Elding Larsson H, Vehik K, Gesualdo P, Akolkar B, Hagopian W, Krischer J, et al. Children followed in the TEDDY study are diagnosed with type 1 diabetes at an early stage of disease. Pediatric diabetes. 2014;15(2):118-26.
4. Piloya-Were T, Sunni M, Ogle GD, Moran A. Childhood diabetes in Africa. Current Opinion in Endocrinology, Diabetes and Obesity. 2016;23(4):306-11.
5. Kyokunzire C, Matovu N. Factors associated with adherence to diabetes care recommendations among children and adolescents with type 1 diabetes: a facility-based study in two urban diabetes clinics in Uganda. Diabetes, metabolic syndrome and obesity: targets and therapy. 2018;11:93.
6. Bahendeka S, Mutungi G, Tugumisirize F, Kamugisha A, Nyangabyaki C, Wesonga R, et al. Healthcare delivery for paediatric and adolescent diabetes in low resource settings: type 1 diabetes clinics in Uganda. Global public health. 2019;14(12):1869-83.
7. He Z. Diagnosis and treatment of diabetic nephropathy in type 1 and type 2 diabetes patients. J Mol Biomark Diagn. 2016;7(5):5-8.
8. Andersen A, Christiansen JS, Andersen J, Kreiner S, Deckert T. Diabetic nephropathy in type 1 (insulin-dependent) diabetes: an epidemiological study. Diabetologia. 1983;25(6):496-501.
9. Orchard T, Secrest A, Miller R, Costacou T. In the absence of kidney disease, 20 year mortality risk in type 1 diabetes is comparable to that of the general population: a report from the Pittsburgh Epidemiology of Diabetes Complications Study. Diabetologia. 2010;53(11):2312-9.
10. Bogdanović R. Diabetic nephropathy in children and adolescents. Pediatric Nephrology. 2008;23(4):507-25.
11. SR SBH, Pavković P, Metelko Ž. Microalbuminuria and Diabetes mellitus. Diabetologia Croatica. 2002;31(4):209.
12. Poulsen L. Early kidney involvement in Type 1 diabetes mellitus—Part 2: ACE inhibitor intervention in Type 1 diabetes with low grade microalbuminuria. Journal of the Renin-Angiotensin-Aldosterone System. 2003;4(1):17-26.
13. Karar T, Alniwaider RAR, Fattah MA, Al Tamimi W, Alanazi A, Qureshi S. Assessment of microalbuminuria and albumin creatinine ratio in patients with type 2 diabetes mellitus. Journal of natural science, biology, and medicine. 2015;6(Suppl 1):S89.
14. Holl RW, Grabert M, Thon A, Heinze E. Urinary excretion of albumin in adolescents with type 1 diabetes: persistent versus intermittent microalbuminuria and relationship to duration of diabetes, sex, and metabolic control. Diabetes Care. 1999;22(9):1555-60.
15. Li L, Jick S, Breitenstein S, Michel A. Prevalence of diabetes and diabetic nephropathy in a large US commercially insured pediatric population, 2002–2013. Diabetes care. 2016;39(2):278-84.
16. Raile K, Galler A, Hofer S, Herbst A, Dunstheimer D, Busch P, et al. Diabetic nephropathy in 27,805 children, adolescents, and adults with type 1 diabetes: effect of diabetes duration, A1C, hypertension, dyslipidemia, diabetes onset, and sex. Diabetes care. 2007;30(10):2523-8.

17. Marshall SL, Edidin DV, Arena VC, Becker DJ, Bunker CH, Gishoma C, et al. Glucose control in Rwandan youth with type 1 diabetes following establishment of systematic, HbA1c based, care and education. Diabetes research and clinical practice. 2015;107(1):113-22.
18. Finne P, Reunanen A, Stenman S, Groop P-H, Grönhagen-Riska C. Incidence of end-stage kidney disease in patients with type 1 diabetes. Jama. 2005;294(14):1782-7.
19. Kalk W, Raal F, Joffe B. The prevalence and incidence of and risk factors for, micro-albuminuria among urban Africans with type 1 diabetes in South Africa: An inter-ethnic study. International Journal of Diabetes Mellitus. 2010;2(3):148-53.
20. Oburu OG. Glycaemic control and prevalence of microalbuminuria among children with type 1 diabetes mellitus attending Mulago Hospital clinic. 2009.
21. Donaghue KC, Marcovecchio ML, Wadwa RP, Chew EY, Wong TY, Calliari LE, et al. ISPAD Clinical Practice Consensus Guidelines 2018: Microvascular and macrovascular complications in children and adolescents. Pediatric diabetes. 2018;19:262.
22. Al-Eisa AA, Al-Hajri A, Al-Shuaib S, Razzak DMA-A, Al-Basiri I. Early-onset microalbuminuria in children with type 1 diabetes in Kuwait. Current Pediatric Research. 2017.
23. Silver B, Ramaiya K, Andrew SB, Fredrick O, Bajaj S, Kalra S, et al. EADSG guidelines: insulin therapy in diabetes. Diabetes Therapy. 2018;9(2):449-92.
24. Donaghue KC, Marcovecchio ML, Wadwa RP, Chew EY, Wong TY, Calliari LE, et al. ISPAD Clinical Practice Consensus Guidelines 2018: Microvascular and macrovascular complications in children and adolescents. Pediatric Diabetes. 2018;19(Suppl 27):262.
25. Association AD. Diagnosis and classification of diabetes mellitus. Diabetes care. 2013;36(Supplement 1):S67-S74.
26. Skyler JS, Bakris GL, Bonifacio E, Darsow T, Eckel RH, Groop L, et al. Differentiation of diabetes by pathophysiology, natural history, and prognosis. Diabetes. 2017;66(2):241-55.
27. Marcovecchio M, Dalton R, Schwarze C, Prevost A, Neil H, Acerini C, et al. Ambulatory blood pressure measurements are related to albumin excretion and are predictive for risk of microalbuminuria in young people with type 1 diabetes. Diabetologia. 2009;52(6):1173.
28. Afkarian M. Diabetic kidney disease in children and adolescents. Pediatric nephrology. 2015;30(1):65-74.
29. Reinehr T. Type 2 diabetes mellitus in children and adolescents. World journal of diabetes. 2013;4(6):270.
30. Samuel VT, Shulman GI. The pathogenesis of insulin resistance: integrating signaling pathways and substrate flux. The Journal of clinical investigation. 2016;126(1):12-22.
31. Schwartz SS, Epstein S, Corkey BE, Grant SF, Gavin JR, Aguilar RB. The time is right for a new classification system for diabetes: rationale and implications of the β-cell–centric classification schema. Diabetes care. 2016;39(2):179-86.
32. Hall V, Thomsen RW, Henriksen O, Lohse N. Diabetes in Sub Saharan Africa 1999-2011: epidemiology and public health implications. A systematic review. BMC public health. 2011;11(1):564.
33. Noble JA, Valdes AM. Genetics of the HLA region in the prediction of type 1 diabetes. Current diabetes reports. 2011;11(6):533.
34. Park Y. Why is type 1 diabetes uncommon in Asia? Annals of the New York Academy of Sciences. 2006;1079(1):31-40.
35. Regnell SE, Lernmark Å. Early prediction of autoimmune (type 1) diabetes. Diabetologia. 2017;60(8):1370-81.
36. Egro FM. Why is type 1 diabetes increasing. J Mol Endocrinol. 2013;51(1):R1-13.

37. Majaliwa E, Ramaiya K. I. 14 Epidemiology of diabetes in children in Africa. Diabetes Research and Clinical Practice. 2014;103:S5.
38. Dabelea D, Mayer-Davis EJ, Saydah S, Imperatore G, Linder B, Divers J, et al. Prevalence of type 1 and type 2 diabetes among children and adolescents from 2001 to 2009. Jama. 2014;311(17):1778-86.
39. Simó R, Hernández C. Treatment of diabetes mellitus: General goals and clinical practice management. Revista espanola de cardiologia. 2002;55(8):845-60.
40. International Diabetes Federation (IDF) Atlas. [Internet]. 2019.
41. Smart CE, Annan F, Higgins LA, Jelleryd E, Lopez M, Acerini CL. ISPAD Clinical Practice Consensus Guidelines 2018: Nutritional management in children and adolescents with diabetes. 2018.
42. Gross JL, De Azevedo MJ, Silveiro SP, Canani LH, Caramori ML, Zelmanovitz T. Diabetic nephropathy: diagnosis, prevention, and treatment. Diabetes care. 2005;28(1):164-76.
43. Caramori ML, Fioretto P, Mauer M. Low glomerular filtration rate in normoalbuminuric type 1 diabetic patients: an indicator of more advanced glomerular lesions. Diabetes. 2003;52(4):1036-40.
44. Francis J, Rose S, Raafat F, Milford D. Early onset of diabetic nephropathy. Archives of disease in childhood. 1997;77(6):524-5.
45. Jensen T, Borch-Johnsen K, Kofoed-Enevoldsen A, Deckert T. Coronary heart disease in young type 1 (insulin-dependent) diabetic patients with and without diabetic nephropathy: incidence and risk factors. Diabetologia. 1987;30(3):144-8.
46. Saunders W. KDOQI clinical practice guidelines and clinical practice recommendations for diabetes and chronic kidney disease. 2007.
47. Svensson M, Eriksson JW, Dahlquist G. Early glycemic control, age at onset, and development of microvascular complications in childhood-onset type 1 diabetes: a population-based study in northern Sweden. Diabetes care. 2004;27(4):955-62.
48. Yarhere IE, Jaja T, Anolue M. Microalbuminuria in type 1 diabetes mellitus children in University of Port Harcourt Teaching Hospital, Nigeria. The Pan African Medical Journal. 2020;36.
49. Ramaphane T, Gezmu AM, Tefera E, Gabaitiri L, Nchingane S, Matsheng-Samuel M, et al. Prevalence and Factors Associated with Microalbuminuria in Pediatric Patients with Type 1 Diabetes Mellitus at a Large Tertiary-Level Hospital in Botswana. Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy. 2021;14:4415.
50. Rissassi J, Nseka M, Jadoul M, Lepira FB, Mvitu M, Mbenza G, et al. Prevalence and determinants of microalbuminuria and macroalbuminuria in children and young adults with type 1 diabetes in Kinshasa. Nephrologie & therapeutique. 2009;6(1):40-6.
51. Control TD, Group CDR. Effect of intensive therapy on the development and progression of diabetic nephropathy in the Diabetes Control and Complications Trial. Kidney International. 1995;47(6):1703-20.
52. Marcovecchio ML, Dalton RN, Prevost AT, Acerini CL, Barrett TG, Cooper JD, et al. Prevalence of abnormal lipid profiles and the relationship with the development of microalbuminuria in adolescents with type 1 diabetes. Diabetes care. 2009;32(4):658-63.
53. Chase HP, Garg SK, Marshall G, Berg CL, Harris S, Jackson WE, et al. Cigarette smoking increases the risk of albuminuria among subjects with type I diabetes. Jama. 1991;265(5):614-7.

54. Quinn M, Angelico M, Warram J, Krolewski A. Familial factors determine the development of diabetic nephropathy in patients with IDDM. Diabetologia. 1996;39(8):940-5.
55. Marcovecchio M, Dalton R, Schwarze C, Prevost A, Neil H, Acerini C, et al. Ambulatory blood pressure measurements are related to albumin excretion and are predictive for risk of microalbuminuria in young people with type 1 diabetes. Diabetologia. 2009;52(6):1173-81.
56. Campos-Pastor M, Escobar-Jimenez F, Mezquita P, Herrera-Pombo J, Hawkins-Carranza F, Luna J, et al. Factors associated with microalbuminuria in type 1 diabetes mellitus: a cross-sectional study. Diabetes research and clinical practice. 2000;48(1):43-9.
57. Amin R, Schultz C, Ong K, Frystyk J, Dalton RN, Perry L, et al. Low IGF-I and elevated testosterone during puberty in subjects with type 1 diabetes developing microalbuminuria in comparison to normoalbuminuric control subjects: the Oxford Regional Prospective Study. Diabetes Care. 2003;26(5):1456-61.
58. Gallego PH, Bulsara MK, Frazer F, Lafferty AR, Davis EA, Jones TW. Prevalence and risk factors for microalbuminuria in a population-based sample of children and adolescents with T1DM in Western Australia. Pediatric diabetes. 2006;7(3):165-72.
59. Stone ML, Craig ME, Chan AK, Lee JW, Verge CF, Donaghue KC. Natural history and risk factors for microalbuminuria in adolescents with type 1 diabetes: a longitudinal study. Diabetes care. 2006;29(9):2072-7.
60. Control D, Group CTR. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. New England journal of medicine. 1993;329(14):977-86.
61. Perkins BA, Ficociello LH, Ostrander BE, Silva KH, Weinberg J, Warram JH, et al. Microalbuminuria and the risk for early progressive kidney function decline in type 1 diabetes. Journal of the American Society of Nephrology. 2007;18(4):1353-61.
62. Lv J, Perkovic V, Foote CV, Craig ME, Craig JC, Strippoli GF. Antihypertensive agents for preventing diabetic kidney disease. Cochrane Database of Systematic Reviews. 2012(12).
63. Statistics UBo. 2019.
64. Flynn JT, Kaelber DC, Baker-Smith CM, Blowey D, Carroll AE, Daniels SR, et al. Clinical practice guideline for screening and management of high blood pressure in children and adolescents. Pediatrics. 2017;140(3).
65. Group DRiCNS. A multicenter study of the accuracy of the One Touch® Ultra® home glucose meter in children with Type 1 diabetes. Diabetes technology & therapeutics. 2003;5(6):933-41.
66. Lakshmy R, Gupta R. Measurement of glycated hemoglobin A1c from dried blood by turbidimetric immunoassay. Journal of diabetes science and technology. 2009;3(5):1203-6.
67. Wilcox AA, Carroll WE, Sterling RE, Davis HA, Ware AG. Use of the Berthelot Reaction in the Automated Analysis of Serum Urea Nitrogen. Clinical Chemistry. 1966;12(3):151-7.
68. Peake M, Whiting M. Measurement of serum creatinine–current status and future goals. Clinical biochemist reviews. 2006;27(4):173.
69. Clark Jr LC, Thompson H. Determination of creatine and creatinine in urine. Analytical Chemistry. 1949;21(10):1218-21.
70. NKDEP. Urine Albumin-to-Creatinine Ratio (UACR) In evaluating patients with Diabetes for KidneyDisease. NIH Publication No 08-6286 •. May 2008(May 2008).

71. Schwartz GJ, Work DF. Measurement and estimation of GFR in children and adolescents. Clinical Journal of the American Society of Nephrology. 2009;4(11):1832-43.
72. Majaliwa ES, Munubhi E, Ramaiya K, Mpembeni R, Sanyiwa A, Mohn A, et al. Survey on acute and chronic complications in children and adolescents with type 1 diabetes at Muhimbili National Hospital in Dar es Salaam, Tanzania. Diabetes care. 2007;30(9):2187-92.
73. Iyengar SK, Abboud HE, Goddard KA, Saad MF, Adler SG, Arar NH, et al. Genome-wide scans for diabetic nephropathy and albuminuria in multiethnic populations: the family investigation of nephropathy and diabetes (FIND). Diabetes. 2007;56(6):1577-85.
74. Satchell S, Tooke J. What is the mechanism of microalbuminuria in diabetes: a role for the glomerular endothelium? Diabetologia. 2008;51(5):714-25.
75. Chaturvedi N, Bandinelli S, Mangili R, Penno G, Rottiers RE, Fuller JH, et al. Microalbuminuria in type 1 diabetes: rates, risk factors and glycemic threshold. Kidney international. 2001;60(1):219-27.
76. Hovind P, Tarnow L, Rossing P, Graae M, Torp I, Binder C, et al. Predictors for the development of microalbuminuria and macroalbuminuria in patients with type 1 diabetes: inception cohort study. Bmj. 2004;328(7448):1105.
77. Hostetter TH, Rennke HG, Brenner BM. The case for intrakidney hypertension in the initiation and progression of diabetic and other glomerulopathies. The American journal of medicine. 1982;72(3):375-80.
78. Lurbe E, Redon J, Kesani A, Pascual JM, Tacons J, Alvarez V, et al. Increase in nocturnal blood pressure and progression to microalbuminuria in type 1 diabetes. New England Journal of Medicine. 2002;347(11):797-805.
79. Schultz C, Neil H, Dalton R, Dunger D, Group ORPS. Risk of nephropathy can be detected before the onset of microalbuminuria during the early years after diagnosis of type 1 diabetes. Diabetes care. 2000;23(12):1811-5.
80. Magee GM, Bilous R, Cardwell CR, Hunter SJ, Kee F, Fogarty DG. Is hyperfiltration associated with the future risk of developing diabetic nephropathy? A meta-analysis. Springer; 2009. p. 691-7.
81. Jerums G, Premaratne E, Panagiotopoulos S, MacIsaac RJ. The clinical significance of hyperfiltration in diabetes. Diabetologia. 2010;53(10):2093-104.
82. Amin R, Turner C, van Aken S, Bahu TK, Watts A, Lindsell DR, et al. The relationship between microalbuminuria and glomerular filtration rate in young type 1 diabetic subjects: The Oxford Regional Prospective Study. Kidney international. 2005;68(4):1740-9.

APPENDIX I; SCREENING WORKSHEET.

PREVALENCE AND FACTORS ASSOCIATED WITH MICROALBUMINURIA IN CHILDREN AND ADOLESCENTS WITH TYPE 1 DIABETES; A STUDY IN MULAGO AND NSAMBYA HOSPITALS IN UGANDA.

Screening number …….

Date of interview……

Answer the FOLLOWING questions by marking the corresponding box. If participant responds YES to any of the questions below, participant is not eligible.

	YES	NO
Is the participant aged between 6months and 19 years?		
Does the participant have Type 1 DM (according to the clinic's guidelines)?		
Has the participant had Type 1 DM for a minimum duration of 1 year?		
Is the participant already on Angiotensin Converting Enzyme inhibitors?		

Does the participant have any of the following symptoms?

	Yes	No
❖ Fever (temperature)	[ ]	[ ]
❖ Lower Abdominal pain	[ ]	[ ]
❖ Dysuria	[ ]	[ ]
❖ foul smelling urine	[ ]	[ ]
❖ Urinary urgency	[ ]	[ ]
❖ Suprapubic tenderness	[ ]	[ ]

Does the participant have any of the following results on urine dipstick?

❖ Leucocytes	[ ]	[ ]
❖ Nitrites	[ ]	[ ]
❖ Protein ≥ +	[ ]	[ ]

	YES	**NO**
IS PARTICIPANT ELIGIBLE?		

If participant is eligible, write participant number ……..

Investigator name…… Investigator signature…….

APPENDIX II: DATA COLLECTION TOOL

PREVALENCE AND FACTORS ASSOCIATED WITH MICROALBUMINURIA IN CHILDREN AND ADOLESCENTS WITH TYPE 1 DIABETES; A STUDY IN MULAGO AND NSAMBYA HOSPITALS IN UGANDA.

A. <u>Sociodemographics</u>

Screening number……File No……..Date of visit dd/mm/yyyy

Participant number …….

Date of birth dd/mm/yyyy Age…/…(years/months).

Sex Female [ ] Male [ ]

Address LC I ……..LC III ……Tel…….

District; Kampala [ ] Wakiso [ ] Mukono [ ] Other [ ]…….

Relationship of caretaker to patient

Parent Grandparent Aunt/uncle Legal guardian

Other (give details) …….

Level of education of child/adolescent Primary Secondary Tertiary

Other

Level of education of caretaker Primary Secondary Tertiary Other

If other give details; ……..

Do you smoke cigarettes, Yes [ ] No [ ] if yes how many sticks per day……...

Do you drink alcohol Yes [ ] No [ ] if yes how many bottles per sitting……

B. <u>Clinical history (tick where appropriate)</u>

Reason for clinic visit: routine visit [ ] Complaint [ ] No complaint [ ]

If complaint tick as appropriately	Yes	No
❖ Fever (temperature)	[ ]	[ ]
❖ Vomiting	[ ]	[ ]
❖ Abdominal pain/menses	[ ]	[ ]
❖ Dysuria,	[ ]	[ ]
❖ foul smelling urine	[ ]	[ ]

- urinary urgency [ ] [ ]
- suprapubic tenderness [ ] [ ]
- hematuria. [ ] [ ]
- Joint pains [ ] [ ]
- Headache [ ] [ ]
- Cough [ ] [ ]
- Chest pain [ ] [ ]
- None of the above (specify)……

C. Diabetes history

- Date of diagnosis of Type 1 DM……dd/mm/yyyy…….
- Age at diagnosis of Type 1 DM……/…….(years/months)
- Duration of Type 1 DM……(months)
- HbA1c at diagnosis……
- Most recent HbA1c…… Date …/…/…dd/mm/yyyy.
- Presence of DKA at diagnosis Yes [ ] No [ ]

D. Current diabetes management

- Insulin …… Yes [ ] No [ ]
- Insulin usage: Number of injections per day 1[ ] 2 [ ] 3[ ] >3[ ]
- Units of insulin per day PB[ ] PL [ ] PS[ ] Total [ ]
- Number of days without insulin 1[ ] 2 [ ] 3[ ] >3[ ]
- How is Insulin stored? Fridge [ ] Pot [ ] Other [ ]
- Number of days you had to take less insulin in the last month 1[ ] 2 [ ] 3[ ] >3[ ]
- Number of days in last three months without insulin 1[ ] 2 [ ] 3[ ] >3[ ]

- ❖ Having a glucometer at home Yes [ ] No [ ]
- ❖ If yes; How often do you use it? Once a day [ ] twice a day [ ] three times [ ]
- ❖ Having glucose-test strips Yes [ ] No [ ]
- ❖ Having a Blood pressure machine Yes [ ] No [ ]

Clinical care:

Frequency of the following in 3 – months:

- ❖ Sick day Clinic visits; 1 [ ] 2 [ ] 3 [ ] >3 [ ]
- ❖ Hb_{AIc} measurement; once [ ] twice [ ] >3 times [ ]
- ❖ No of times of diabetic education in a clinic visit received; 1 [ ] 2 [ ] > 3 [ ]

E. <u>Past medical history</u>

Diabetes acute complications: A scale of 1-5 will be used for *hypoglycaemia episodes (1-single, 2 – double, 3- triple, 4-quadruple and 5 – more than five times)*

- ❖ Acute: Number of episodes of several hypoglycaemia in the preceding 3 months [ ]
- ❖ Number of admissions in the previous year…….
- ❖ Coma [ ] Convulsion [ ] Assistance of another person for Rx [ ]
- ❖ Young children: Confusion [ ], Drowsiness [ ] Requiring immediate Rx [ ]
- ❖ Previous diagnosis of kidney disease Yes [ ] No [ ]
- ❖ Age of pubertal onset……
- ❖ Other Chronic illnesses Yes [ ] No [ ]
- ❖ If yes, specify…….

F. <u>Diet and physical exercise</u>

- ❖ How many times do you exercise during the week?1 [ ] 2 [ ] 3 [ ] >3 [ ]
- ❖ What is your preferred form of physical activity?

Running [ ] dancing [ ] swimming [ ] walking [ ] Aerobics [ ] Other [ ]

G. Family history

- Occupation of caretaker……..
  - Family history of hypertension Yes [ ] No [ ]
  - Family history of kidney disease Yes [ ] No [ ]

H. Physical examination

Anthropometric indices:

- Weight (Kg) [ ] Height (m) [ ] BMI [ ]
- Tanner Staging; stage 1 [ ] Stage 2 [ ] Stage 3 [ ] Stage 4 [ ]

Respiratory system exam

- Respiratory rate: <20bpm [ ] > 20bpm [ ]
- Chest in drawing [ ]
- Crepitations [ ] others ……..

Cardiovascular system

- Blood pressure (mmHg) ;

Value 1..…/…… Value 2……/…… Value 3……/……

- Pulse rate [ ]

- Heart sounds I and II heard Yes [ ] No [ ]
- Added sounds Yes [ ] No [ ]

Central nervous system

- Conscious [ ] Not conscious [ ]

Urinalysis

Sugar …….

Ketones ……

Leukocytes ……

pH……...

Nitrites ……...

Laboratory Request Form

- Random blood sugar [ ]mg/dl or mmol/l.
- Urine Albumin [ ]
- Urine Creatinine [ ]
- Urine albumin/creatinine ratio [ ]mg/g
- Microalbuminuria [ ] No microalbuminuria [ ] overt proteinuria[ ]
- Serum Urea……
- Serum Creatinine……
- HbA1c…….%
- eGFR…….

If applicable;
Participant Number ……
Second Test for microalbuminuria (at 1 month)
Date……./……/……

Urinalysis

Sugar …….

Ketones ……

Leukocytes ……

pH……...

Nitrites ……...

- ❖ Urine Albumin [ ]
- ❖ Urine Creatinine [ ]
- ❖ Urine albumin/creatinine ratio [ ]mg/g
- ❖ Microalbuminuria [ ] No microalbuminuria [ ] overt proteinuria[ ]

Participant number ……..
Third Test for microalbuminuria (at 3 month)
Date……./……/……

Urinalysis

Sugar …….

Ketones ……

Leukocytes ……

pH……...

Nitrites ……...

- ❖ Urine Albumin [ ]
- ❖ Urine Creatinine [ ]
- ❖ Urine albumin/creatinine ratio [ ]mg/g
- ❖ Microalbuminuria [ ] No microalbuminuria [ ] overt proteinuria[ ]

APPENDIX III; PARENTAL STUDY CONSENT FORM

Study title;

PREVALENCE AND FACTORS ASSOCIATED WITH MICROALBUMINURIA IN CHILDREN AND ADOLESCENTS WITH TYPE 1 DIABETES; A STUDY IN MULAGO AND NSAMBYA HOSPITALS IN UGANDA.

Introduction;

I am (representing) Dr. Sanyu Kirabo Lubwama from the Department of Pediatrics and Child Health, Makerere University College of Heath Sciences, P.O. Box 7072 Kampala, Uganda, Telephone number +256(0)774498166.

Email address: kirabo.sanyu@yahoo.com, sanyukirabo4@gmail.com

Background and rationale for the study

Kidney disease is one of the major causes of morbidity and mortality among patients with Diabetes Mellitus. It results in poor general health, increased hospitalizations, further risk of diabetes complications. When the kidneys are not working well, they do not sieve out protein. This results in small amounts of protein in urine which is one of the earliest signs of kidney disease known as microalbuminuria. At this point, the disease can be reversed with medication. Therefore, this study aims at determining the number of patients at this stage of the disease and the factors associated with developing microalbuminuria.

This study will be carried out in both Mulago National Referral Hospital and St. Francis Hospital Nsambya on children and adolescents aged 18 months – 19 years. A total of 217 participants will be included in the study.

The information obtained from this study will inform us of the burden and factors associated with microalbuminuria in our setting. It will assist the clinicians in designing guidelines for better screening and prevention of long term End stage kidney disease (ESKD). This information will also be shared with policy makers to improve the care of patients with Type 1 Diabetes Mellitus.

Purpose of the study

You are being requested to allow your child to participate in this study whose purpose is to determine how common this subtle increase in protein excretion is in children and adolescents with Type 1 Diabetes Mellitus attending diabetic clinics of both Mulago and Nsambya hospitals in Kampala Uganda. It will also help to determine the factors that put these children at risk of this subtle increase in protein excretion.

Estimated duration of the interview

It will take about 30 minutes for the entire interview. It involves answering a few questions we have, examining the child and measure their height, weight and blood pressure. And finally taking off blood and urine samples for analysis.

Study procedure

You will be asked a few questions about your child's age, diabetes history, current management of the illness and a full physical examination including; vital signs like breathing rate, pulse rate temperature and blood pressure measurements. Other aspects of the physical examination will include; weight, height, listening to heart sounds, breath sounds and level of consciousness. Blood and urine samples will be obtained from the child upon your permission on the day of a regular clinic visit. The blood sample (10mls) will be drawn for random blood sugar, level of blood glucose control in the last 3 months and to check how his/her kidneys are functioning. The urine sample will be used to determine your child's likelihood of developing early kidney disease. It will an on-spot fresh urine sample of approximately 5 milliliters collected at the outpatient department If the first urine sample done is positive, we will reassess the child after one month and then after 2 months to confirm the positivity of the result. However if it is negative, we will continue to advise that the test be repeated annually. A high level of hygiene will be ensured by cleaning the area where the blood is going to be drawn using 70% alcohol and 10% iodine solutions.

Who will participate in the study?

We estimate that about 217 participants aged between 18 months and 19 years with Type 1 Diabetes Mellitus being managed and followed up at both Nsambya and Mulago hospital diabetic clinics will participate in the study.

Risks and discomforts

Your child will feel a little and brief pain during the process of taking off blood. Apart from that, we do not expect any other serious risks. The amount of blood removed will be too small and will not affect the health of the child. This will be done by well-trained personnel who will conduct the test swiftly and minimize the pain as much as possible.

During the process of measuring blood pressure, weight and height, your child may find it uncomfortable, but this will be short-lived and will not harm the child in any way.

Benefits

Participation in the research will not yield any immediate and direct benefits to you or your child. However, the knowledge gained from the study will be used to benefit all children and adolescents with Type 1 Diabetes Mellitus through new set protocols for timely and better health service provision.

Respect and confidentiality

The information collected will only be used for research purposes. The form will have a special number and not your name, the information will be securely stored with the main investigator.

Voluntary Participation

Entry into the study is entirely voluntary and no penalty will be given for not taking part in the study. Should you choose to withdraw from the study anytime for any reason, you are free to do so and this will not affect your treatment or future participation in research in any way.

Cost:

The blood and urine samples drawn will be run by the research team at no cost to the participant or their guardian.

Compensation

You and your child will not be provided with any payment to take part in the research. However a fee of 10,000 Ugandan shillings only at each visit will be provided for those who are called back for a second and third visit to cater for travel expenses. There will be no compensation for any injury incurred during the study but should any occur, your child will be referred for appropriate management.

Dissemination of results:

All research participants will get their individual blood and urine test results obtained during this study. Feedback on findings and progress of the study will also be provided. Any new information that affects the study or data that has clinical relevance to research your child (including incidental findings) will be made available to you and/or their health care providers.

Contacts for further information

For any questions related to the study please contact Dr. Sanyu Kirabo Lubwama on the number 0774498166 or any of my supervisors at any point during or after the study using the following numbers

Dr Angelina Kakooza 077299583

Dr Batte Anthony 0775684462

Dr Piloya Thereza Were 0781461621

Dr Catherine Nyangabyaki 0772443173.

For questions regarding the rights or any other ethical issue concerning your child, you may contact Professor Ocama Ponsiano the chairman School of Medicine Research and Ethics Committee on telephone number +256772421190.

STATEMENT OF CONSENT

..... has described to me what is going to be done to my daughter/son, the risks, the benefits involved and rights regarding this study.I have had an opportunity to ask questions and they have been answered to my satisfaction. I understand that my decision for my child to participate in this study will not alter his/her usual medical care. In the use of this information, my child's identity will be concealed. I am aware that I may

withdraw my child at any time. I understand that by signing this form, I do not waive any of my legal rights but merely indicate that I have been informed about the research study in which I am voluntarily agreeing for my child to participate. A copy of this form will be provided to me.

Name ……thumbprint/Signature of parent/guardian Date ……...

Name …….Signature of interviewer/Person obtaining informed consent ……Date …….

APPENDIX IV; STUDY ASSENT FORM

Study title;

PREVALENCE AND FACTORS ASSOCIATED WITH MICROALBUMINURIA IN CHILDREN AND ADOLESCENTS WITH TYPE 1 DIABETES; A STUDY IN MULAGO AND NSAMBYA HOSPITALS IN UGANDA.

Introduction;

I am (representing) Dr. Sanyu Kirabo Lubwama from the Department of Pediatrics and Child Health, Makerere University College of Heath Sciences, P.O. Box 7072 Kampala, Uganda, Telephone number +256(0)774498166.

Email address: kirabo.sanyu@yahoo.com, sanyukirabo4@gmail.com

What is a research study?

We want to tell you about something we are doing called a research study. A research study is when doctors collect a lot of information to learn more about something. Dr. Sanyu Kirabo Lubwama and her team are doing a study to learn more about children with diabetes mellitus like you. After we tell you about it, we will ask if you'd like to be in this study or not.

Why are we doing this study?

We want to find out how well your sugar levels are controlled and also whether you have the early markers of kidney disease which can happen in children with diabetes. So we are getting information from lots of boys and girls like you. In the whole research study, there will be about 217 children from Mulago and Nsambya hospitals who have diabetes.

What will happen to you if you are in this study?

1. The study doctor will ask you and your mum or dad a few questions about your health. You will also have a physical examination done to see how well you are doing and growing.
2. A small amount of your blood will be drawn. That means it will be taken by a needle in your arm. You will also give some urine for testing.

3. If the urine test is positive that means you will need to stay in the study for 3 months and visit the clinic two more times for urine tests only.

Will this study hurt?

The prick from the needle to draw your blood will hurt, but the hurt will go away after a while. When your blood pressure is being taken, the cuff used may also squeeze a little but this will go away.

Will you get better if you are in this study?

No, this study won't make you feel better or get well. But the doctors might find out something that will help other children like you later.

Do you have any questions?

You can ask questions any time you like. You can ask now or later. You can talk to Dr. Sanyu or the nurse working on you. You can also ask your parents to ask the questions for you.

Do you have to be in this study?

No, you don't. No one will be angry at you if you don't want to do this. If you don't want to be in this study, just tell us. Or if you do want to be in the study, tell us that. And, remember, you can say yes now and change your mind later. It's up to you.

The doctor will give you a copy of this form to keep.

SIGNATURE OF PERSON CONDUCTING ASSENT DISCUSSION

I have explained the study to _____(*print name of child here*) in language he/she can understand, and the child has agreed to be in the study.

_____ _____

Signature of Person Conducting Assent Discussion **Date**

_____

Name of Person Conducting Assent Discussion (*print*)

APPENDIX V; STUDY CONSENT FORM

Study title;

PREVALENCE AND FACTORS ASSOCIATED WITH MICROALBUMINURIA IN CHILDREN AND ADOLESCENTS WITH TYPE 1 DIABETES; A STUDY IN MULAGO AND NSAMBYA HOSPITALS IN UGANDA.

Introduction;

I am (representing) Dr. Sanyu Kirabo Lubwama from the Department of Pediatrics and Child Health, Makerere University College of Heath Sciences, P.O. Box 7072 Kampala, Uganda, Telephone number +256(0)774498166.

Email address: kirabo.sanyu@yahoo.com, sanyukirabo4@gmail.com

Background and rationale for the study

Kidney disease is one of the major causes of morbidity and mortality among patients with Diabetes Mellitus. It results in poor general health, increased hospitalizations, further risk of diabetes complications. When the kidneys are not working well, they do not sieve out protein. This results in subtle amounts of protein in urine which is one of the earliest signs of kidney disease known as microalbuminuria. At this point, the disease can be reversed with medication. Therefore, this study aims at determining the number of patients at this stage of the disease and the factors associated with developing these subtle amounts of protein in urine.

This study will be carried out in both Mulago National Referral Hospital and St. Francis Hospital Nsambya on children and adolescents aged 18 months – 19 years. A total of 217 participants will be included in the study.

The information obtained from this study will inform us of the burden and factors associated with developing these subtle amounts of protein in urine in our setting. It will assist the clinicians in designing guidelines for better screening and prevention of long term End stage kidney disease (ESKD). This information will also be shared with policy makers to improve the care of patients with Type 1 Diabetes Mellitus.

Purpose of the study

You are being requested to participate in this study whose purpose is to determine how common this subtle amounts of protein in urine is in children and adolescents with Type 1 Diabetes Mellitus attending diabetic clinics of both Mulago and Nsambya hospitals in Kampala Uganda. It will also help to determine the factors that put these patients at risk of this subtle amounts of protein in urine.

Estimated duration of the interview

It will take about 30 minutes for the entire interview. It involves answering a few questions we have, examining you and measuring your height, weight and blood pressure. And finally taking off blood and urine samples for analysis.

Study procedure

You will be asked a few questions about your age, diabetes history, current management of the illness and a full physical examination including; vital signs like breathing rate, pulse rate temperature and blood pressure measurements. Other aspects of the physical examination will include; weight, height, listening to heart sounds, breath sounds and level of consciousness. Blood and urine samples will be obtained upon your permission on the day of a regular clinic visit. The blood sample (10mls) will be drawn for random blood sugar, level of blood glucose control in the last 3 months and to check how his/her kidneys are functioning. The urine sample will be used to determine your likelihood of developing early kidney disease. It will an on-spot fresh urine sample of approximately 5 milliliters collected at the outpatient department If the first urine sample done is positive, we will reassess you after one month and then after 2 months to confirm the positivity of the result. However if it is negative, we will continue to advise that the test be repeated annually. A high level of hygiene will be ensured by cleaning the area where the blood is going to be drawn using 70% alcohol and 10% iodine solutions.

Who will participate in the study?

We estimate that about 217 participants aged between 18 months and 19 years with Type 1 Diabetes Mellitus being managed and followed up at both Nsambya and Mulago hospital diabetic clinics will participate in the study.

Risks and discomforts

You will feel a little and brief pain during the process of taking off blood. Apart from that, we do not expect any other serious risks. The amount of blood removed will be too small and will not affect your health. This will be done by well-trained personnel who will conduct the test swiftly and minimize the pain as much as possible.

During the process of measuring blood pressure, weight and height, you may find it uncomfortable, but this will be short-lived and will not harm you in any way.

Benefits

Participation in the research will not yield any immediate and direct benefits to you. However, the knowledge gained from the study will be used to benefit all children and adolescents with Type 1 Diabetes Mellitus through new set protocols for timely and better health service provision.

Respect and confidentiality

The information collected will only be used for research purposes. The form will have a special number and not your name, the information will be securely stored with the main investigator.

Voluntary Participation

Entry into the study is entirely voluntary and no penalty will be given for not taking part in the study. Should you choose to withdraw from the study anytime for any reason, you are free to do so and this will not affect your treatment or future participation in research in any way.

Cost:

The blood and urine samples drawn will be run by the research team at no cost to the participant or their guardian.

Compensation

You will not be provided with any payment to take part in the research. However a fee of 10,000 Ugandan shillings only at each visit will be provided for those who are called back for a second and third visit to cater for travel expenses. There will be no compensation for any injury incurred during the study but should any occur, you will be referred for appropriate management.

Dissemination of results:

All research participants will get their individual blood and urine test results obtained during this study. Feedback on findings and progress of the study will also be provided. Any new information that affects the study or data that has clinical relevance to research your child (including incidental findings) will be made available to you and/or their health care providers.

Contacts for further information

For any questions related to the study please contact Dr. Sanyu Kirabo Lubwama on the number 0774498166 or any of my supervisors at any point during or after the study using the following numbers

Dr Angelina Kakooza 077299583

Dr Batte Anthony 0775684462

Dr Piloya Thereza Were 0781461621

Dr Catherine Nyangabyaki 0772443173.

For questions regarding the rights or any other ethical issue concerning your child, you may contact Professor Ocama Ponsiano the chairman School of Medicine Research and Ethics Committee on telephone number +256772421190.

STATEMENT OF CONSENT

..... has described to me what is going to be done to me, the risks, the benefits involved and rights regarding this study.I have had an opportunity to ask questions and they have been answered to my satisfaction. I understand that my decision for me to participate in this study will not alter my usual medical care. In the use of this information, my identity will be concealed. I am aware that I may withdraw at any time. I understand that by signing this form, I do not waive any of my legal rights but merely indicate that I have been

informed about the research study in which I am voluntarily agreeing to participate. A copy of this form will be provided to me.

Name ……thumbprint/Signature of participant. Date ……...

Name …….Signature of interviewer/Person obtaining informed consent ……Date …….

APPENDIX V; PARENTAL CONSENT FORM IN LUGANDA.

ENKOOKELO IV: FOOMU ERAGA NTI OMUZADDE AKIRIZZA OMWANA WE

OKWETABA MU KUNONYEREZA

Omutwe gw'okunonyereza:

ENGERI GYE BAKOSEBWA N'ENSONGA EZIREETERA ABAANA N'ABAVUBUKA ABALINA OBULWADDE BWA SUKAALI (*TYPE 1 DIABETES*) OKUBA NGA BAFULUMYA EBIRUNGO BYA *PROTEIN* MU MUSULO GW'ABWE (*MICROALBUMINURIA*); OKUNONYEREZA MU MALWALIRO AGE NSAMBYA NE MULAGO MU UGANDA.

Enyanjula:

Nze nkiikiridde Dr. Sanyu Kirabo Lubwama okuva mu kitongole ekijanjaba abaana wamu n'okukola ku nsonga za baana mu Makerere University College of Heath Sciences, akasanduuko ka posta nnamba 7072 Kampala, Uganda, essimu nnamba +256(0)774498166.
Endagiriro ya Email: kirabo.sanyu@yahoo.com, sanyukirabo4@gmail.com

Omusingi ne nsonga lwaki tutaddewo okunonyereza kuno

Endwadde ye nsigo (Kidney) kye kimu ku bintu eby'ongera obulwadde n'okufa mu balwadde ba sukaali. Kileetera embeera y'obulamu okwononeka, kileetera omulwadde okuba nga takyava mu ddwaliro, okwo nga kw'otadde n'obulwadde bwa sukaali okw'eyongera. Ensigo bwe ziba tezikola bulungi, tezisobola kusunsula bulungi kiriisa ky'omubiri ekya Protein. Kino kileetera ekiriisa kino okugendera mu musulo, era kano ke kamu ku bubonero obusookera ddala ak'obulwadde bwe nsigo (microalbuminuria). Mu kiseera kino obulwadde buno buyinza okujanjabibwa ng'abulina aweereddwa eddagala. N'olwekyo ekiluubirirwa ky'okunonyereza kuno, kwe kumanya omuwendo gw'abalwadde abali ku ssa lino n'ensonga ezekuusa ku kileeta obulwadde bwe nsigo (microalbuminuria).
Okunonyereza kuno kugenda kukolelwa mu malwaliro omuli eddwaliro eddene elya Mulago ne lya St. Francis Hospital Nsambya, ku baana n'abavubuka abali wakati w'emyeezi 6 n'emyaaka 19. Abantu abawerera ddala 217 be baneetaba mu kunonyereza kuno.
Byonna bye tunafuna mu kunonyereza kuno bigya kutuyamba okumanya omuguggu gw'obulwadde buno ne nsonga endala ezekuusa ku bulwadde bwe nsigo (microalbuminuria) mu mbeera yaffe. Bijja kuyamba abasawo abajanjaba abalwadde okutema empenda mwe banayitanga okukebera obulungi k'okuyamba mu kw'ekuuma obulwadde bwe nsigo obuli ku ssa ly'obutakyawona. Bye tunazuula era bigenda kugabanibwa n'abakwatibwako bateme empenda z'okujanjaba n'okulabirira obulungi abalwadde ba sukaali.

Ekiluubirirwa ky okunonyereza kuno

Osabibwa okukiriza omwana wo okubeera mu kunonyereza okuluubirira okumanya ebizibu n'ensonga ezikwatagana ne ekizibu kya abaana ko abavuka abalina obulwadde bwa sukaali (Type 1 Diabetes Mellitus) okufulumya ekiriisa ekya protein mu musulo (microalbuminuria). Okunonyereza kuno kukolebwa ku baana na bavubuka abajanjabirwa mu malwaliro age Mulago ne Nsambya obulwadde bwa sukaali.

Ekiseera kye tunamala ng tukubaganya ebirowoozo (interview)

Okukubaganya ebirowoozo kuno nga tuliko bye tukubuuza kwa kumala edakiika nga 30. Ogya kuddamu ebibuuzo bitonotono bye tunakubuuza, twekebejje omwana, tupime obuwanvu bwe, obuzito bwe wamu ne ntununsi (puleesa). Oluvanyuma tugya kumugyko omusaayi n'omusulo by'ekebegyebwe.

Ebinagobererwa mu kunonyereza kuno

Ojja kubuuzibwa ebibuuzo bitono omuli emyaka gy'omwana wo, ebyafaayo bye ku bulwadde bwa sukaali, engeri gy'ajjanjabibwamu era omwana wo ayongere okukeberebwa. Omwana wo ajjakujjibwako omusaayi no musulo bw'onaaba okirizza ku lunaku lwe munaaba muzze mu kyirinika. Omusaayi oguwera mls nga 10 gwa kumugyibwako okukebera obungi bwa sukaali mu mubiri, b'alondoole n'obungi bwa sukaali mu musaayi mu myezi esatu egyiyise, era beekebegye balabe oba ensigo ze zikola bulungi. Omusulo gwa kumugyibwako basobole okukebera ensigo (Kidney), balabe oba nga zitandise okulwala. Ajja kugyibwako milliliters nga 5 ezo musulo era ogusooka bwe gualaga nti ensigo zitandise okulwala tujja kuddamu tumwekebegye oluvanyuma lw'omwezi gumu, tuddemu oluvanyuma lwe emeyezi ebiri tukakase. Wabula bwe tutazuula bulwadde, tujja kuwabula okuddamu okukebera omusulo omulundi gumu buli mwaka.

Omutindo gwe by'obuyonjo gugya kuba gwa wagulu nyo nga tulongoosa awagenda okugyibwa omusaayi era ekirungo omuli omwenge (Alcohol) oguweza ebitundu 70 ku buli 100 ne Iodine ebitundu 10 ku 100 kye kinakozesebwa.

Baani abanaaba mu kunonyereza kuno?

Tusuubira abantu nga 217 abali wakati wa emyeezi 6 n'emyaka 19 abalina obulwadde bwa sukaali (Type 1 Diabetes Mellitus) nga bafunira obujanjabi mu bitongole ebijanjaba sukaali mu malwaliro omuli Mulago ne Nsambya be banabeera mu kunonyereza kuno.

Akabi n'obutawulira bulungi

Omwana w'ajja kuwulira obulumi butono nyo mu kaseera katono ddala nga bamukuba akayiso okumujako omusaayi. Ng'ojjeeko ekyo tetusuubirawo kabi kalala kona. Omusaayi ogugenda okumugyibwako mutono ddala era tegugenda kuba na ngeri yonna gye gukosaamu bulamu bwe. Kino kigenda kukolebwa abantu abatendeke obulungi abagenda okukebera amangu ddala nga n'obulumi bw'enyini bwa kuba butono ddala.

Mu kiseera nga bapima entununsi, obuzito, n'obuwanvu omwana ayinza obutawulira bulungi, naye kino kya kaseera katono ddala era tekirina ngeri yona gye kinamukosa.

Okuganyulwa

Okwenyigira mu kunonyereza kuno temuja kuba bya kufuna gy'oli oba omwana wo. Wabula bye tunazuula mu kunonyereza kuno bijja kuyamba okukola ku baana na abavubuka gye bugya abalina sukaali owe kika kino nga abasawo bassaawo enkola empya eneyamba mu kujanjaba.

Okukuuma ebyama n'okusa ekitiibwa mu bantu

Amawulire oba bye tugenda okufuna mu kunonyereza kuno bya kukozesebwa mu kunonyereza kwokka. Foomu eno egenda kubaako nnamba so ssi linya lyo, era bye tunazuula bya kukuumibwa omunonyereza omukulu.

Eddembe lya omuntu mu kunonyereza

Okwetaba mu kunonyereza kuno kwa kyeyagalire era tewali kibonerezo kinaweebwa muntu yenna olw'obutakwetabaamu. Oli wa ddembe okuva mu kunonyereza kuno bwoba oyagadde okukuvaamu obudde bwonna, era kino tekigya kukosa bujanjabi mwana wo bw'afuna.

Okusasula:
Okuja ku mwana wo omusaayi no musulo okukeberebwa bijja kukolebwa awatali kusasula wadde omunwe gwe nnusu.

Okusasulwa
Gwe n'omwana wo temugenda kusasulwa olw'okwetaba mu kunonyereza kuno. Wabula omutwalo gwe nsimbi za Uganda gumu (10,000) gwa kuwebwa buli abanaaba bayitiddwa nate omulundi ogw'okubiri, n'ogw'okusatu okusasulira ebye ntambula yaabwe. Tewali nsimbi zinasasulwa olwo obuvune omwana wo bwatuseeko mu kunonyereza kuno, era kino bwe kibaawo wakuwerezebwa afune obujanjabi.

Okufulumya ebivudde mu kukeberwa:
Bonna abali mu kunonyereza kuno baakufuna ebivudde mu kubakebera omusulo no musaayi. Ebirala ebiba bizuuliddwa nabyo bya kubaweebwanga. Amawulire gonna amappya agayinza okukosa okunonyereza kunno era nga ga mugaso nago gakuweebwa abali mu kunonyereza kuno n'eri abo abali mu by'obujanjabi.

Endagiriro bw'oba olina ebirala by'oyagadde okumanya.
Bw'oba olina ebirala by'oyagala okumanya ku kunonyereza kuno oyinza okukubira Dr. Sanyu Kirabo Lubwama ku nnamba ye ssimu 0774498166 oba abakulu mu kunonyereza kuno ku nnamba ze ssimu zinno wamanga
Dr. Angelina Kakooza ku ssimu nnamba 077299583
Dr Batte Anthony ku ssimu nnamba 0775684462
Dr Piloya Thereza Were ku ssimu nnamba 0781461621
Dr Catherine Nyangabyaki ku ssimu nnamba 0772443173.
Ebibuuzo ebikwatagana ku ddembe lyo muntu mu kunonyereza oba ensonga zona ezikwatagana ku neyisa mu kunonyereza ku mwana wo kubira Pulofeesa Ocama Ponsiano, Ssentebe wa kakiiko akavunanyizibwa ku by'okunonyereza mu bye ddagala n'akaiiko ake mpisa mu banonyereza ku ssimu nnamaba +256772421190.

OKULANGIRIRA OKUKIRIZA OMWANA
..... anyinyonyodde ebigenda okukolebwa ku mwana wange, akabi akayinza okubaamu, engeri gy'ayinza okuganyulwa ne eddembe lyo mwana wange mu kunonyereza kuno. Nfunye omukisa okubaako bye mbuuza era byonna abizzeemu ne matira. Nkitegedde bulungi nti ekyo omwana wange okwetaba mu kunonyereza kuno tekigya kudobonkanyamu ngeri gyafunamu bujanjabi. Mu kukozesa ebivudde mu kunonyereza, amanya go omwana wange tegagenda kumanyibwa. Nkimanyi bulungi nti nyinza okusalawo okujja omwana wange mu kunonyereza kuno obudde bwonna. Nkimanyi nti bwe nzisa omukono ku foomu eno mba segyeko ddembe lyange, wabula kiba kitegeeza nti nyinyonyoddwa ku ku kunonyereza kuno, era ne nzikiriza omwana wange okwenyigiramu nga neyagalidde. Kopi eya foomu eno egenda kumpeebwa.

Elinya ……Ekinkumu/Omukono gwo muzadde/mukuza
Ennaku z'omwezi…….....
Elinya……..Omukono gw'abadde ayogera n'omuzadde/ omuntu afunye okukiriza kw'omuzadde Ennaku z'omwezi …….

APPENDIX VI; ASSENT FORM IN LUGANDA

ENKOOKELO V FOOMU ERAGA NTI OMWANA AKIRIZA OKWETABA MU KUNONYEREZA

Omutwe gw'okunonyereza:

ENGERI GYE BAKOSEBWA N'ENSONGA EZIREETERA ABAANA N'ABAVUBUKA ABALINA OBULWADDE BWA SUKAALI (*TYPE 1 DIABETES*) OKUBA NGA BAFULUMYA EBIRUNGO BYA *PROTEIN* MU MUSULO GW'ABWE (*MICROALBUMINURIA*); OKUNONYEREZA MU MALWALIRO AGE NSAMBYA NE MULAGO MU UGANDA

Enyanjula:
Nze nkiikiridde Dr. Sanyu Kirabo Lubwama okuva mu kitongole ekijanjaba abaana wamu n'okukola ku nsonga za baana mu Makerere University College of Heath Sciences, akasanduuko ka posta nnamba 7072 Kampala, Uganda, essimu nnamba +256(0)774498166.
Endagiriro ya Email: kirabo.sanyu@yahoo.com, sanyukirabo4@gmail.com

Biki ebiri mu kunonyereza kunno?
Twagala tukuteegeze ebikwata ku kunonyereza. Mu kunonyereza mu by'obulamu abasawo (Ba Dokita) baba baagala okubaako bye bamanya ku bulamu bwa abantu oba okubaako ebippya bye bazuula. Dr. Sanyu Kirabo Lubwama wamu ne baakola n'abo bali mu kunonyereza okubaako bye bazuula ku baana abalina obulwadde bwa sukaali (diabetes mellitus) nga ggwe. Bwe tumala okukutegeeza binno, tujja kukubuuza oba onakiriza okwetaba mu kunonyereza kunno oba nedda.

Lwaki tukola okunonyereza kuno?
Twagala okuzuula engeri esingira ddala obulungi gye tuyinza okukendeeza obungi bwa sukaali mu mubiri, ate tusobole n'okumanya oba olina obubonero obusookerwako obulaga nti ensigo zo zandiba nga zilwala. Kino no kisoboka okubeera mu baana abato abalina obulwadde bwa sukaali. Kakaano tufuna amawulire ng'ago okuva mu baana abalenzi na bawala bangi. Mu kunonyereza kwonna mugenda kubaamu abaana abakunukiriza mu 217 abalina obulwadde bwa sukaali okuva mu malwaliro omuli Mulago ne Nsambya.

Kiki ekinakubaako bw'obeera mu kunonyereza kuno?

1. Omusawo (doctor) ali mu kunonyereza kuno ajja kubuuza maama wo oba taata wo ebibuuzo bitono ebikwata ku bulamu bwo. Mu kiseera kye kimu ojja kwekebejjebwa era okeberwe balabe obulamu bwo n'engeri gy'okulamu.
2. Ojja kugyibwako omusaayi mutono. Kino kitegeeza bajja kukozesa empiso ku mukono gwo nga bakujjako omusaayi. Oja kuwaayo no musulo mutono nagwo gukeberebwe.
3. Bwe bakebera omusulo ne bakizuula nti olina obulwadde kitegeeza nti ojja kubeerera ddala mu kunonyereza kuno okumala emyezi 3 era ojje mu kyiriniki eno emirundi emirala ebiri nga okeberererebwa omusulo.

Waliwo obulumi mu kunonyereza kuno?
Akayiso ke bakufumita okukujjako omusaayi kaluma, naye obulumi buba bwa kaseera katono. Bwe banaaba bapima entunnunsi zo (Pressure) ekikoba ekikozesebwa kinyigamu katono omukono gwo naye kino nakyokya kaseera katono.

Onabeera bulungi bw'obeera mu kunonyereza kunno?
Nedda, okunonyereza kuno tekugenda kukuleetera kuwulira bulungi oba okukuwonya. Naye abasawo bayinza okuzuula engeri endala enayamba abaana abalala abalinga ggwe gye bujja okubeera obulungi.

Olinayo ekibuuzo?
Oyinza okubuuza ebibuuzo obudde bwonna. Oyinza okubuuza kakaano oba gye bujja. Oyinza okwogera ne Dr. Sanyu oba omusawo (Nurse) akukolako. Oyinza n'okusaba abazadde ne babuuza ebibuuzo ku lulwo.

Olina okubeera mu kunonyereza kuno?
Nedda. Tewali agenda kukunyiigira bwotaba mu kunonyereza kuno. Bw'owulira nga toyagala kuba mu kunonyereza kuno, tutegeeze. Bw'owulira nga oyagala okubeera mu kunonyereza kuno, tutegeeze. Jjukira oyinza okukiriza kati ate oluvanyuma n'okyusa ekirowoozo kyo. Kiri gy'oli.

Dokita ajja kukuwa kopi ya foomu eno ogyitereke.

OMUKONO GWO MUNTU ABADDE ABADDE AKUBAGANYA NAAWE EBIROWOOZO OSOBOLE OKUKIRIZA.
Nyinyonyodde ebikwata ku kunonyereza kuno eri_____(*wandiika erinya ly'omwana mu kyapa*) mu lulimi lwategeera era n'akiriza okubeera mu kunonyereza kunno.

_____ _____
Omukono gw'abadde akubaganya ebirowoozo ku kunonyereza nnaku z'amwezi

_____
Elinya ly'abadde akubaganya ebirowoozo ku kunonyereza (*Mu Kyapa*)

APPENDIX VII; STUDY CONSENT FORM IN LUGANDA.

ENKOOKELO IV: FOOMU ERAGA NTI OKIRIZZA OKWETABA MU KUNONYEREZA
Omutwe gw'okunonyereza:

ENGERI GYE BAKOSEBWA N'ENSONGA EZIREETERA ABAANA N'ABAVUBUKA ABALINA OBULWADDE BWA SUKAALI (*TYPE 1 DIABETES*) OKUBA NGA BAFULUMYA EBIRUNGO BYA *PROTEIN* MU MUSULO GW'ABWE (*MICROALBUMINURIA*); OKUNONYEREZA MU MALWALIRO AGE NSAMBYA NE MULAGO MU UGANDA.

Enyanjula:
Nze nkiikiridde Dr. Sanyu Kirabo Lubwama okuva mu kitongole ekijanjaba abaana wamu n'okukola ku nsonga za baana mu Makerere University College of Heath Sciences, akasanduuko ka posta20 nnamba 7072 Kampala, Uganda, essimu nnamba +256(0)774498166.
Endagiriro ya Email: kirabo.sanyu@yahoo.com, sanyukirabo4@gmail.com

Omusingi ne nsonga lwaki tutaddewo okunonyereza kuno
Endwadde ye nsigo (Kidney) kye kimu ku bintu eby'ongera obulwadde n'okufa mu balwadde ba sukaali. Kileetera embeera y'obulamu okwononeka, kileetera omulwadde okuba nga takyava mu ddwaliro, okwo nga kw'otadde n'obulwadde bwa sukaali okw'eyongera. Ensigo bwe ziba tezikola bulungi, tezisobola kusunsula bulungi kiriisa ky'omubiri ekya Protein. Kino kileetera ekiriisa kino okugendera mu musulo, era kano ke kamu ku bubonero obusookera ddala ak'obulwadde bwe nsigo (microalbuminuria). Mu kiseera kino obulwadde buno buyinza okujanjabibwa ng'abulina aweereddwa eddagala. N'olwekyo ekiluubirirwa ky'okunonyereza kuno, kwe kumanya omuwendo gw'abalwadde abali ku ssa lino n'ensonga ezekuusa ku kileeta obulwadde bwe nsigo (microalbuminuria).
Okunonyereza kuno kugenda kukolelwa mu malwaliro omuli eddwaliro eddene elya Mulago ne lya St. Francis Hospital Nsambya, ku baana n'abavubuka abali wakati w'emyeezi 6 n'emyaka 19. Abantu abawerera ddala 217 be baneetaba mu kunonyereza kuno.
Byonna bye tunafuna mu kunonyereza kuno bigya kutuyamba okumanya omuguggu gw'obulwadde buno ne nsonga endala ezekuusa ku bulwadde bwe nsigo (microalbuminuria) mu mbeera yaffe. Bijja kuyamba abasawo abajanjaba abalwadde okutema empenda mwe banayitanga okukebera obulungi k'okuyamba mu kw'ekuuma obulwadde bwe nsigo obuli ku ssa ly'obutakyawona. Bye tunazuula era bigenda kugabanibwa n'abakwatibwako bateme empenda z'okujanjaba n'okulabirira obulungi abalwadde ba sukaali.

Ekiluubirirwa ky okunonyereza kuno
Osabibwa okukiriza okubeera mu kunonyereza okuluubirira okumanya ebizibu n'ensonga ezikwatagana ne ekizibu kya abaana ko abavuka abalina obulwadde bwa sukaali (Type 1 Diabetes Mellitus) okufulumya ekiriisa ekya protein mu musulo (microalbuminuria). Okunonyereza kuno kukolebwa ku baana na bavubuka abajanjabirwa mu malwaliro ag'e Mulago ne Nsambya obulwadde bwa sukaali.

Ekiseera kye tunamala ng tukubaganya ebirowoozo (interview)

Okukubaganya ebirowoozo kuno nga tuliko bye tukubuuza kwa kumala edakiika nga 30. Ogya kuddamu ebibuuzo bitonotono bye tunakubuuza, tukwekebejje, tupime obuwanvu bwo, obuzito bwo wamu ne ntununsi (puleesa). Oluvanyuma tugya kukugyako omusaayi n'omusulo by'ekebegyebwe.

Ebinagobererwa mu kunonyereza kuno

Ojja kubuuzibwa ebibuuzo bitono omuli emyaka gyo, ebyafaayo byo ku bulwadde bwa sukaali, engeri gy'ojjanjabibwamu era nawe oyongere okukeberebwa. Ojjakujjibwako omusaayi no musulo bw'onaaba okirizza ku lunaku lwe munaaba muzze mu kyirinika. Omusaayi oguwera mls nga 10 gwa kugyibwako okukebera obungi bwa sukaali mu mubiri, b'alondoole n'obungi bwa sukaali mu musaayi mu myezi esatu egyiyise, era beekebegye balabe oba ensigo zo zikola bulungi. Omusulo gwa kukugyibwako basobole okukebera ensigo (Kidney), balabe oba nga zitandise okulwala. Ojja kugyibwako milliliters nga 5 ezo musulo era ogusooka bwe gualaga nti ensigo zitandise okulwala tujja kuddamu tukwekebegye oluvanyuma lw'omwezi gumu, tuddemu oluvanyuma lwe emeyezi ebiri tukakase. Wabula bwe tutazuula bulwadde, tujja kuwabula okuddamu okukebera omusulo omulundi gumu buli mwaka.

Omutindo gwe by'obuyonjo gugya kuba gwa wagulu nyo nga tulongoosa awagenda okugyibwa omusaayi era ekirungo omuli omwenge (Alcohol) oguweza ebitundu 70 ku buli 100 ne Iodine ebitundu 10 ku 100 kye kinakozesebwa.

Baani abanaaba mu kunonyereza kuno?

Tusuubira abantu nga 217 abali wakati wa emyeezi 6 n'emyaka 19 abalina obulwadde bwa sukaali (Type 1 Diabetes Mellitus) nga bafunira obujanjabi mu bitongole ebijanjaba sukaali mu malwaliro omuli Mulago ne Nsambya be banabeera mu kunonyereza kuno.

Akabi n'obutawulira bulungi

Ojja kuwulira obulumi butono nyo mu kaseera katono ddala nga bakukuba akayiso okukujako omusaayi. Ng'ojjeeko ekyo tetusuubirawo kabi kalala kona. Omusaayi ogugenda okukugyibwako mutono ddala era tegugenda kuba na ngeri yonna gye gukosaamu bulamu bwo. Kino kigenda kukolebwa abantu abatendeke obulungi abagenda okukebera amangu ddala nga n'obulumi bw'enyini bwa kuba butono ddala.

Mu kiseera nga bapima entununsi, obuzito, n'obuwanvu oyinza obutawulira bulungi, naye kino kya kaseera katono ddala era tekirina ngeri yona gye kinakukosa.

Okuganyulwa

Okwenyigira mu kunonyereza kuno temuja kuba bya kufuna gy'oli. Wabula bye tunazuula mu kunonyereza kuno bijja kuyamba okukola ku baana na abavubuka gye bugya abalina sukaali owe kika kino nga abasawo bassaawo enkola empya eneyamba mu kujanjaba.

Okukuuma ebyama n'okusa ekitiibwa mu bantu

Amawulire oba bye tugenda okufuna mu kunonyereza kuno bya kukozesebwa mu kunonyereza kwokka. Foomu eno egenda kubaako nnamba so ssi linya lyo, era bye tunazuula bya kukuumibwa omunonyereza omukulu.

Eddembe lya omuntu mu kunonyereza
Okwetaba mu kunonyereza kuno kwa kyeyagalire era tewali kibonerezo kinaweebwa muntu yenna olw'obutakwetabaamu. Oli wa ddembe okuva mu kunonyereza kuno bwoba oyagadde okukuvaamu obudde bwonna, era kino tekigya kukosa bujanjabi bwo bw'ofuna.

Okusasula:
Okukuja ko omusaayi no musulo okukeberebwa bijja kukolebwa awatali kusasula wadde omunwe gwe nnusu.

Okusasulwa
Togenda kusasulwa olw'okwetaba mu kunonyereza kuno. Wabula omutwalo gwe nsimbi za Uganda gumu (10,000) gwa kuwebwa buli mwana oba omuvubuka ayitiddwa nate omulundi ogw'okubiri, n'ogw'okusatu okusasulira ebye ntambula yaabwe. Tewali nsimbi zinasasulwa olwo obuvune bwotuseeko mu kunonyereza kuno, era kino bwe kibaawo wakuwerezebwa afune obujanjabi.

Okufulumya ebivudde mu kukeberwa:
Bonna abali mu kunonyereza kuno baakufuna ebivudde mu kubakebera omusulo no musaayi. Ebirala ebiba bizuuliddwa nabyo bya kubaweebwanga. Amawulire gonna amappya agayinza okukosa okunonyereza kunno era nga ga mugaso nago gakuweebwa abali mu kunonyereza kuno n'eri abo abali mu by'obujanjabi.

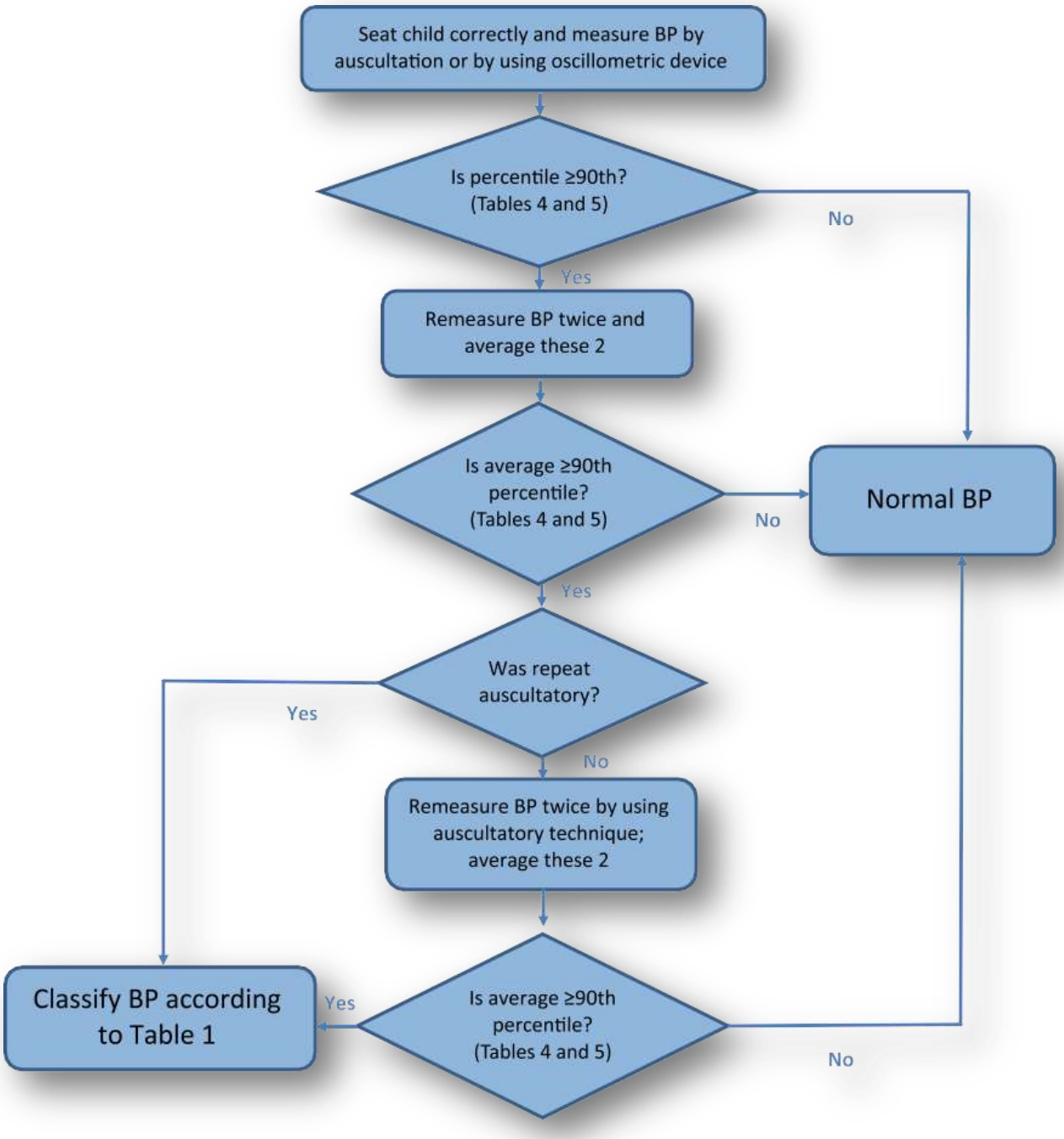
Endagiriro bw'oba olina ebirala by'oyagadde okumanya.
Bw'oba olina ebirala by'oyagala okumanya ku kunonyereza kuno oyinza okukubira Dr. Sanyu Kirabo Lubwama ku nnamba ye ssimu 0774498166 oba abakulu mu kunonyereza kuno ku nnamba ze ssimu zinno wamanga
Dr. Angelina Kakooza ku ssimu nnamba 077299583
Dr Batte Anthony ku ssimu nnamba 0775684462
Dr Piloya Thereza Were ku ssimu nnamba 0781461621
Dr Catherine Nyangabyaki ku ssimu nnamba 0772443173.
Ebibuuzo ebikwatagana ku ddembe lyo muntu mu kunonyereza oba ensonga zona ezikwatagana ku neyisa mu kunonyereza ku mwana wo kubira Pulofeesa Ocama Ponsiano, Ssentebe wa kakiiko akavunanyizibwa ku by'okunonyereza mu bye ddagala n'akaiiko ake mpisa mu banonyereza ku ssimu nnamaba +256772421190.

OKULANGIRIRA OKUKIRIZA OMWANA
..... anyinyonyodde ebigenda okukolebwa mukunonyereza kunno, akabi akayinza okubaamu, engeri gy'ayinza okuganyulwa ne eddembe lyange mu kunonyereza kuno. Nfunye omukisa okubaako bye mbuuza era byonna abizzeemu ne matira. Nkitegedde bulungi nti okwetaba mu kunonyereza kuno tekigya kudobonkanyamu ngeri gyenfunamu bujanjabi. Mu kukozesa ebivudde mu kunonyereza, amanya gange tegagenda kumanyibwa. Nkimanyi bulungi nti nyinza okusalawo okuva mu kunonyereza kuno obudde bwonna. Nkimanyi nti bwe nzisa omukono ku foomu eno mba segyeko ddembe lyange, wabula

kiba kitegeeza nti nyinyonyoddwa ku ku kunonyereza kuno, era ne nzikiriza okwenyigiramu nga neyagalidde. Kopi eya foomu eno egenda kumpeebwa.

Elinya ……Ekinkumu/Omukono gwange
Ennaku z'omwezi…….....
Elinya……..Omukono gw'abadde ayogera nange/ omuntu afunye okukiriza kwange Ennaku z'omwezi …….

APPENDIX VIII



APPENDIX IX

TABLE 4 BP Levels for Boys by Age and Height Percentile

Age (y)	BP Percentile	SBP (mm Hg)							DBP (mm Hg)						
		Height Percentile or Measured Height							Height Percentile or Measured Height						
		5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
1	Height (in)	30.4	30.8	31.6	32.4	33.3	34.1	34.6	30.4	30.8	31.6	32.4	33.3	34.1	34.6
	Height (cm)	77.2	78.3	80.2	82.4	84.6	86.7	87.9	77.2	78.3	80.2	82.4	84.6	86.7	87.9
	50th	85	85	86	86	87	88	88	40	40	40	41	41	42	42
	90th	98	99	99	100	100	101	101	52	52	53	53	54	54	54
	95th	102	102	103	103	104	105	105	54	54	55	55	56	57	57
	95th + 12 mm Hg	114	114	115	115	116	117	117	66	66	67	67	68	69	69
2	Height (in)	33.9	34.4	35.3	36.3	37.3	38.2	38.8	33.9	34.4	35.3	36.3	37.3	38.2	38.8
	Height (cm)	86.1	87.4	89.6	92.1	94.7	97.1	98.5	86.1	87.4	89.6	92.1	94.7	97.1	98.5
	50th	87	87	88	89	89	90	91	43	43	44	44	45	46	46
	90th	100	100	101	102	103	103	104	55	55	56	56	57	58	58
	95th	104	105	105	106	107	107	108	57	58	58	59	60	61	61
	95th + 12 mm Hg	116	117	117	118	119	119	120	69	70	70	71	72	73	73
3	Height (in)	36.4	37	37.9	39	40.1	41.1	41.7	36.4	37	37.9	39	40.1	41.1	41.7
	Height (cm)	92.5	93.9	96.3	99	101.8	104.3	105.8	92.5	93.9	96.3	99	101.8	104.3	105.8
	50th	88	89	89	90	91	92	92	45	46	46	47	48	49	49
	90th	101	102	102	103	104	105	105	58	58	59	59	60	61	61
	95th	106	106	107	107	108	109	109	60	61	61	62	63	64	64
	95th + 12 mm Hg	118	118	119	119	120	121	121	72	73	73	74	75	76	76
4	Height (in)	38.8	39.4	40.5	41.7	42.9	43.9	44.5	38.8	39.4	40.5	41.7	42.9	43.9	44.5
	Height (cm)	98.5	100.2	102.9	105.9	108.9	111.5	113.2	98.5	100.2	102.9	105.9	108.9	111.5	113.2
	50th	90	90	91	92	93	94	94	48	49	49	50	51	52	52
	90th	102	103	104	105	105	106	107	60	61	62	62	63	64	64
	95th	107	107	108	108	109	110	110	63	64	65	66	67	67	68
	95th + 12 mm Hg	119	119	120	120	121	122	122	75	76	77	78	79	79	80
5	Height (in)	41.1	41.8	43.0	44.3	45.5	46.7	47.4	41.1	41.8	43.0	44.3	45.5	46.7	47.4
	Height (cm)	104.4	106.2	109.1	112.4	115.7	118.6	120.3	104.4	106.2	109.1	112.4	115.7	118.6	120.3
	50th	91	92	93	94	95	96	96	51	51	52	53	54	55	55
	90th	103	104	105	106	107	108	108	63	64	65	65	66	67	67
	95th	107	108	109	109	110	111	112	66	67	68	69	70	70	71
	95th + 12 mm Hg	119	120	121	121	122	123	124	78	79	80	81	82	82	83
6	Height (in)	43.4	44.2	45.4	46.8	48.2	49.4	50.2	43.4	44.2	45.4	46.8	48.2	49.4	50.2
	Height (cm)	110.3	112.2	115.3	118.9	122.4	125.6	127.5	110.3	112.2	115.3	118.9	122.4	125.6	127.5
	50th	93	93	94	95	96	97	98	54	54	55	56	57	57	58
	90th	105	105	106	107	109	110	110	66	66	67	68	68	69	69
	95th	108	109	110	111	112	113	114	69	70	70	71	72	72	73

	95th + 12 mm Hg	120	121	122	123	124	125	126	81	82	82	83	84	84	85
7	Height (in)	45.7	46.5	47.8	49.3	50.8	52.1	52.9	45.7	46.5	47.8	49.3	50.8	52.1	52.9
	Height (cm)	116.1	118	121.4	125.1	128.9	132.4	134.5	116.1	118	121.4	125.1	128.9	132.4	134.5
	50th	94	94	95	97	98	98	99	56	56	57	58	58	59	59
	90th	106	107	108	109	110	111	111	68	68	69	70	70	71	71
	95th	110	110	111	112	114	115	116	71	71	72	73	73	74	74
	95th + 12 mm Hg	122	122	123	124	126	127	128	83	83	84	85	85	86	86

TABLE 4 Continued

Age (y)	BP Percentile	SBP (mm Hg)							DBP (mm Hg)						
		Height Percentile or Measured Height							Height Percentile or Measured Height						
		5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
8	Height (in)	47.8	48.6	50	51.6	53.2	54.6	55.5	47.8	48.6	50	51.6	53.2	54.6	55.5
	Height (cm)	121.4	123.5	127	131	135.1	138.8	141	121.4	123.5	127	131	135.1	138.8	141
	50th	95	96	97	98	99	99	100	57	57	58	59	59	60	60
	90th	107	108	109	110	111	112	112	69	70	70	71	72	72	73
	95th	111	112	112	114	115	116	117	72	73	73	74	75	75	75
	95th + 12 mm Hg	123	124	124	126	127	128	129	84	85	85	86	87	87	87
9	Height (in)	49.6	50.5	52	53.7	55.4	56.9	57.9	49.6	50.5	52	53.7	55.4	56.9	57.9
	Height (cm)	126	128.3	132.1	136.3	140.7	144.7	147.1	126	128.3	132.1	136.3	140.7	144.7	147.1
	50th	96	97	98	99	100	101	101	57	58	59	60	61	62	62
	90th	107	108	109	110	112	113	114	70	71	72	73	74	74	74
	95th	112	112	113	115	116	118	119	74	74	75	76	76	77	77
	95th + 12 mm Hg	124	124	125	127	128	130	131	86	86	87	88	88	89	89
10	Height (in)	51.3	52.2	53.8	55.6	57.4	59.1	60.1	51.3	52.2	53.8	55.6	57.4	59.1	60.1
	Height (cm)	130.2	132.7	136.7	141.3	145.9	150.1	152.7	130.2	132.7	136.7	141.3	145.9	150.1	152.7
	50th	97	98	99	100	101	102	103	59	60	61	62	63	63	64
	90th	108	109	111	112	113	115	116	72	73	74	74	75	75	76
	95th	112	113	114	116	118	120	121	76	76	77	77	78	78	78
	95th + 12 mm Hg	124	125	126	128	130	132	133	88	88	89	89	90	90	90
11	Height (in)	53	54	55.7	57.6	59.6	61.3	62.4	53	54	55.7	57.6	59.6	61.3	62.4
	Height (cm)	134.7	137.3	141.5	146.4	151.3	155.8	158.6	134.7	137.3	141.5	146.4	151.3	155.8	158.6
	50th	99	99	101	102	103	104	106	61	61	62	63	63	63	63
	90th	110	111	112	114	116	117	118	74	74	75	75	75	76	76
	95th	114	114	116	118	120	123	124	77	78	78	78	78	78	78
	95th + 12 mm Hg	126	126	128	130	132	135	136	89	90	90	90	90	90	90
12	Height (in)	55.2	56.3	58.1	60.1	62.2	64	65.2	55.2	56.3	58.1	60.1	62.2	64	65.2
	Height (cm)	140.3	143	147.5	152.7	157.9	162.6	165.5	140.3	143	147.5	152.7	157.9	162.6	165.5
	50th	101	101	102	104	106	108	109	61	62	62	62	62	63	63
	90th	113	114	115	117	119	121	122	75	75	75	75	75	76	76
	95th	116	117	118	121	124	126	128	78	78	78	78	78	79	79
	95th + 12 mm Hg	128	129	130	133	136	138	140	90	90	90	90	90	91	91
13	Height (in)	57.9	59.1	61	63.1	65.2	67.1	68.3	57.9	59.1	61	63.1	65.2	67.1	68.3
	Height (cm)	147	150	154.9	160.3	165.7	170.5	173.4	147	150	154.9	160.3	165.7	170.5	173.4
	50th	103	104	105	108	110	111	112	61	60	61	62	63	64	65
	90th	115	116	118	121	124	126	126	74	74	74	75	76	77	77

	95th	119	120	122	125	128	130	131	78	78	78	78	80	81	81
	95th + 12 mm Hg	131	132	134	137	140	142	143	90	90	90	90	92	93	93
14	Height (in)	60.6	61.8	63.8	65.9	68.0	69.8	70.9	60.6	61.8	63.8	65.9	68.0	69.8	70.9
	Height (cm)	153.8	156.9	162	167.5	172.7	177.4	180.1	153.8	156.9	162	167.5	172.7	177.4	180.1
	50th	105	106	109	111	112	113	113	60	60	62	64	65	66	67
	90th	119	120	123	126	127	128	129	74	74	75	77	78	79	80
	95th	123	125	127	130	132	133	134	77	78	79	81	82	83	84
	95th + 12 mm Hg	135	137	139	142	144	145	146	89	90	91	93	94	95	96

TABLE 4 Continued

Age (y)	BP Percentile	SBP (mm Hg)							DBP (mm Hg)						
		Height Percentile or Measured Height							Height Percentile or Measured Height						
		5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
15	Height (in)	62.6	63.8	65.7	67.8	69.8	71.5	72.5	62.6	63.8	65.7	67.8	69.8	71.5	72.5
	Height (cm)	159	162	166.9	172.2	177.2	181.6	184.2	159	162	166.9	172.2	177.2	181.6	184.2
	50th	108	110	112	113	114	114	114	61	62	64	65	66	67	68
	90th	123	124	126	128	129	130	130	75	76	78	79	80	81	81
	95th	127	129	131	132	134	135	135	78	79	81	83	84	85	85
	95th + 12 mm Hg	139	141	143	144	146	147	147	90	91	93	95	96	97	97
16	Height (in)	63.8	64.9	66.8	68.8	70.7	72.4	73.4	63.8	64.9	66.8	68.8	70.7	72.4	73.4
	Height (cm)	162.1	165	169.6	174.6	179.5	183.8	186.4	162.1	165	169.6	174.6	179.5	183.8	186.4
	50th	111	112	114	115	115	116	116	63	64	66	67	68	69	69
	90th	126	127	128	129	131	131	132	77	78	79	80	81	82	82
	95th	130	131	133	134	135	136	137	80	81	83	84	85	86	86
	95th + 12 mm Hg	142	143	145	146	147	148	149	92	93	95	96	97	98	98
17	Height (in)	64.5	65.5	67.3	69.2	71.1	72.8	73.8	64.5	65.5	67.3	69.2	71.1	72.8	73.8
	Height (cm)	163.8	166.5	170.9	175.8	180.7	184.9	187.5	163.8	166.5	170.9	175.8	180.7	184.9	187.5
	50th	114	115	116	117	117	118	118	65	66	67	68	69	70	70
	90th	128	129	130	131	132	133	134	78	79	80	81	82	82	83
	95th	132	133	134	135	137	138	138	81	82	84	85	86	86	87
	95th + 12 mm Hg	144	145	146	147	149	150	150	93	94	96	97	98	98	99

Use percentile values to stage BP readings according to the scheme in Table 3 (elevated BP: ≥90th percentile; stage 1 HTN: ≥95th percentile; and stage 2 HTN: ≥95th percentile + 12 mm Hg). The 50th, 90th, and 95th percentiles were derived by using quantile regression on the basis of normal-weight children (BMI <85th percentile).[77]

TABLE 5 BP Levels for Girls by Age and Height Percentile

Age (y)	BP Percentile	SBP (mm Hg)							DBP (mm Hg)						
		Height Percentile or Measured Height							Height Percentile or Measured Height						
		5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
1	Height (in)	29.7	30.2	30.9	31.8	32.7	33.4	33.9	29.7	30.2	30.9	31.8	32.7	33.4	33.9
	Height (cm)	75.4	76.6	78.6	80.8	83	84.9	86.1	75.4	76.6	78.6	80.8	83	84.9	86.1
	50th	84	85	86	86	87	88	88	41	42	42	43	44	45	46
	90th	98	99	99	100	101	102	102	54	55	56	56	57	58	58
	95th	101	102	102	103	104	105	105	59	59	60	60	61	62	62
	95th + 12 mm Hg	113	114	114	115	116	117	117	71	71	72	72	73	74	74

2	Height (in)	33.4	34	34.9	35.9	36.9	37.8	38.4	33.4	34	34.9	35.9	36.9	37.8	38.4
	Height (cm)	84.9	86.3	88.6	91.1	93.7	96	97.4	84.9	86.3	88.6	91.1	93.7	96	97.4
	50th	87	87	88	89	90	91	91	45	46	47	48	49	50	51
	90th	101	101	102	103	104	105	106	58	58	59	60	61	62	62
	95th	104	105	106	106	107	108	109	62	63	63	64	65	66	66
	95th + 12 mm Hg	116	117	118	118	119	120	121	74	75	75	76	77	78	78
3	Height (in)	35.8	36.4	37.3	38.4	39.6	40.6	41.2	35.8	36.4	37.3	38.4	39.6	40.6	41.2
	Height (cm)	91	92.4	94.9	97.6	100.5	103.1	104.6	91	92.4	94.9	97.6	100.5	103.1	104.6
	50th	88	89	89	90	91	92	93	48	48	49	50	51	53	53
	90th	102	103	104	104	105	106	107	60	61	61	62	63	64	65
	95th	106	106	107	108	109	110	110	64	65	65	66	67	68	69
	95th + 12 mm Hg	118	118	119	120	121	122	122	76	77	77	78	79	80	81
4	Height (in)	38.3	38.9	39.9	41.1	42.4	43.5	44.2	38.3	38.9	39.9	41.1	42.4	43.5	44.2
	Height (cm)	97.2	98.8	101.4	104.5	107.6	110.5	112.2	97.2	98.8	101.4	104.5	107.6	110.5	112.2
	50th	89	90	91	92	93	94	94	50	51	51	53	54	55	55
	90th	103	104	105	106	107	108	108	62	63	64	65	66	67	67
	95th	107	108	109	109	110	111	112	66	67	68	69	70	70	71
	95th + 12 mm Hg	119	120	121	121	122	123	124	78	79	80	81	82	82	83
5	Height (in)	40.8	41.5	42.6	43.9	45.2	46.5	47.3	40.8	41.5	42.6	43.9	45.2	46.5	47.3
	Height (cm)	103.6	105.3	108.2	111.5	114.9	118.1	120	103.6	105.3	108.2	111.5	114.9	118.1	120
	50th	90	91	92	93	94	95	96	52	52	53	55	56	57	57
	90th	104	105	106	107	108	109	110	64	65	66	67	68	69	70
	95th	108	109	109	110	111	112	113	68	69	70	71	72	73	73
	95th + 12 mm Hg	120	121	121	122	123	124	125	80	81	82	83	84	85	85
6	Height (in)	43.3	44	45.2	46.6	48.1	49.4	50.3	43.3	44	45.2	46.6	48.1	49.4	50.3
	Height (cm)	110	111.8	114.9	118.4	122.1	125.6	127.7	110	111.8	114.9	118.4	122.1	125.6	127.7
	50th	92	92	93	94	96	97	97	54	54	55	56	57	58	59
	90th	105	106	107	108	109	110	111	67	67	68	69	70	71	71
	95th	109	109	110	111	112	113	114	70	71	72	72	73	74	74
	95th + 12 mm Hg	121	121	122	123	124	125	126	82	83	84	84	85	86	86
7	Height (in)	45.6	46.4	47.7	49.2	50.7	52.1	53	45.6	46.4	47.7	49.2	50.7	52.1	53
	Height (cm)	115.9	117.8	121.1	124.9	128.8	132.5	134.7	115.9	117.8	121.1	124.9	128.8	132.5	134.7
	50th	92	93	94	95	97	98	99	55	55	56	57	58	59	60
	90th	106	106	107	109	110	111	112	68	68	69	70	71	72	72
	95th	109	110	111	112	113	114	115	72	72	73	73	74	74	75
	95th + 12 mm Hg	121	122	123	124	125	126	127	84	84	85	85	86	86	87

TABLE 5 Continued

Age (y)	BP Percentile	SBP (mm Hg)							DBP (mm Hg)						
		Height Percentile or Measured Height							Height Percentile or Measured Height						
		5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
8	Height (in)	47.6	48.4	49.8	51.4	53	54.5	55.5	47.6	48.4	49.8	51.4	53	54.5	55.5
	Height (cm)	121	123	126.5	130.6	134.7	138.5	140.9	121	123	126.5	130.6	134.7	138.5	140.9
	50th	93	94	95	97	98	99	100	56	56	57	59	60	61	61
	90th	107	107	108	110	111	112	113	69	70	71	72	72	73	73
	95th	110	111	112	113	115	116	117	72	73	74	74	75	75	75

	95th + 12 mm Hg	122	123	124	125	127	128	129	84	85	86	86	87	87	87
9	Height (in)	49.3	50.2	51.7	53.4	55.1	56.7	57.7	49.3	50.2	51.7	53.4	55.1	56.7	57.7
	Height (cm)	125.3	127.6	131.3	135.6	140.1	144.1	146.6	125.3	127.6	131.3	135.6	140.1	144.1	146.6
	50th	95	95	97	98	99	100	101	57	58	59	60	60	61	61
	90th	108	108	109	111	112	113	114	71	71	72	73	73	73	73
	95th	112	112	113	114	116	117	118	74	74	75	75	75	75	75
	95th + 12 mm Hg	124	124	125	126	128	129	130	86	86	87	87	87	87	87
10	Height (in)	51.1	52	53.7	55.5	57.4	59.1	60.2	51.1	52	53.7	55.5	57.4	59.1	60.2
	Height (cm)	129.7	132.2	136.3	141	145.8	150.2	152.8	129.7	132.2	136.3	141	145.8	150.2	152.8
	50th	96	97	98	99	101	102	103	58	59	59	60	61	61	62
	90th	109	110	111	112	113	115	116	72	73	73	73	73	73	73
	95th	113	114	114	116	117	119	120	75	75	76	76	76	76	76
	95th + 12 mm Hg	125	126	126	128	129	131	132	87	87	88	88	88	88	88
11	Height (in)	53.4	54.5	56.2	58.2	60.2	61.9	63	53.4	54.5	56.2	58.2	60.2	61.9	63
	Height (cm)	135.6	138.3	142.8	147.8	152.8	157.3	160	135.6	138.3	142.8	147.8	152.8	157.3	160
	50th	98	99	101	102	104	105	106	60	60	60	61	62	63	64
	90th	111	112	113	114	116	118	120	74	74	74	74	74	75	75
	95th	115	116	117	118	120	123	124	76	77	77	77	77	77	77
	95th + 12 mm Hg	127	128	129	130	132	135	136	88	89	89	89	89	89	89
12	Height (in)	56.2	57.3	59	60.9	62.8	64.5	65.5	56.2	57.3	59	60.9	62.8	64.5	65.5
	Height (cm)	142.8	145.5	149.9	154.8	159.6	163.8	166.4	142.8	145.5	149.9	154.8	159.6	163.8	166.4
	50th	102	102	104	105	107	108	108	61	61	61	62	64	65	65
	90th	114	115	116	118	120	122	122	75	75	75	75	76	76	76
	95th	118	119	120	122	124	125	126	78	78	78	78	79	79	79
	95th + 12 mm Hg	130	131	132	134	136	137	138	90	90	90	90	91	91	91
13	Height (in)	58.3	59.3	60.9	62.7	64.5	66.1	67	58.3	59.3	60.9	62.7	64.5	66.1	67
	Height (cm)	148.1	150.6	154.7	159.2	163.7	167.8	170.2	148.1	150.6	154.7	159.2	163.7	167.8	170.2
	50th	104	105	106	107	108	108	109	62	62	63	64	65	65	66
	90th	116	117	119	121	122	123	123	75	75	75	76	76	76	76
	95th	121	122	123	124	126	126	127	79	79	79	79	80	80	81
	95th + 12 mm Hg	133	134	135	136	138	138	139	91	91	91	91	92	92	93
14	Height (in)	59.3	60.2	61.8	63.5	65.2	66.8	67.7	59.3	60.2	61.8	63.5	65.2	66.8	67.7
	Height (cm)	150.6	153	156.9	161.3	165.7	169.7	172.1	150.6	153	156.9	161.3	165.7	169.7	172.1
	50th	105	106	107	108	109	109	109	63	63	64	65	66	66	66
	90th	118	118	120	122	123	123	123	76	76	76	76	77	77	77
	95th	123	123	124	125	126	127	127	80	80	80	80	81	81	82
	95th + 12 mm Hg	135	135	136	137	138	139	139	92	92	92	92	93	93	94

APPENDIX X; ACTIVITY TIMELINE

Activity/ Period	**Feb 2020**	**SEPT 2020**	**Oct 2020 - Mar 2021**	**march 2021**	**April 2021**	**May 2021**	**May 2021**	**May 2021**
Departmental presentation								
IRB presentation and approval								
Data collection								
Data analysis								
Complete thesis writing								
Department Defence								
Mock defence corrections								
Submit through the department for Marking								

APPENDIX XI: BUDGET

Item	Quantity	Unit cost UGX	Total cost UGX
One touch ultra Glucometer	1	350,000	350,000/=
Glucosticks	250	1000	250,000/=
Weighing scale	1	100,000	100,000/=
Non stretchable tape	2	2500/=	5,000/=
Welch Allyn manual BP machine	1	480,000/=	480,000/=
Welch Allyn pediatric BP cuffs	3	86,000/=	258,000/=
Battery pack	1	100,000/=	100,000/=
Vacutainers	420	1000/=	420,000/=
Syringes	3 boxes	12,000/=	36,000/=
Sample carrier	1	200,000/=	200,000/=
Urine sample bottles	210	1000	210,000/=
Urine dipsticks(100 tests per bottle)	3	55,500/=	166500
Urine albumin testing kit for 100 tests	3	800,000/=	2,400,000/=
Calibrators	1	300,000/=	300,000/=
Controls both normal and pathological	1	400,000/=	400,000/=
Urine creatinine (1 cassette 300 tests)	1	350,000/=	350,000/=
HBA1c testing kit (150 tests)	2	600,000/=	1,200,000/=
Calibrator	1	350,000/=	350,000/=
Serum creatinine testing kits	2	125,000/=	250,000/=
Serum Urea testing kits	2	125,000/=	250,000/=
Labour and Bench fee	1	2,000,000/=	2,000,000/=
Research assistants	2	@300,000/=	600,000/=
Statistician	1	@ 1,000,000/=	1,000,000/=
Proposal printing (Department)	66 pages X 20 copies	@ page 100/=	132,000/=
Proposal printing (IRB)	66 pages×11 copies	100/= per page	72,600/=
IRB fees	100,000/=	100,000/=	100,000/=
Printing (Questionnaires)	6 pages × 217 copies	100/= per page	130,200/=
Printing (screening	1 page x 500	100/= per page	50,000/=

worksheets)	copies		
Printing consent forms	3 pages × 217 copies	100/= per page	65,100/=
Printing assent forms	2 pages × 180 copies	100/= per page	36,000/=
Printing (Report)	100 pages × 3 copies	100/= per page	30,000/=
Printing (Final thesis)	100 pages × 5 copies	100/= per page	50,000/=
Pens	1 box	5000	5,000
Note books	4	5000	5,000
Dissemination	5	20,000/=	60,000/=
Training of research assistants	3	50,000/=	150,000/=
Transport allowance for participants	106 participants	5000/=	515,000/=
Miscellaneous		1,000, 000/=	1,000,000/=
Total			14,086,100/=