PREVALENCE AND FACTORS ASSOCIATED WITH MALNUTRITION AMONG PATIENTS WITH SICKLE CELL DISEASE IN DAR ES SALAAM, TANZANIA

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By

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A Dissertation Submitted in partial fulfilment of the requirement for the Degree of Master of Medicine in Haematology and Blood Transfusion of

Muhimbili University of Health and Allied Sciences

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CERTIFICATION

The undersigned certify that she has read and hereby recommend for acceptance by Muhimbili University of Healthy and Allied Sciences a dissertation entitled "***Prevalence and factors associated with malnutrition among patients with sickle cell disease in Dar es Salaam, Tanzania***" in partial fulfilment of the requirement for the degree of Master of Medicine in Haematology and Blood Transfusion of Muhimbili University of Health and Allied Sciences.

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DECLARATION AND COPYRIGHT

I **Dr Evelyne Modestus Banda** declare that this dissertation is my own original work and that it has not been presented and will not be presented to any other university for similar or any degree award.

Signature…… Date…….

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DEDICATION

To all children with sickle cell disease, we love them and want the best for them

Abstract

Sickle cell disease (SCD) and its variants are genetic disorders resulting from the presence of a mutated form of hemoglobin, HbS. The disease occurs as a result of a point mutation in the β-globin chain of Hb molecule; where a non-polar amino acid, valine, is substituted for a polar amino acid, glutamic acid. Africa has the greatest burden of SCD, with up to 75% of the 300,000 global births per year and where childhood mortality remains high, ranging 50 - 90%.

It is known that homozygous (SS) sickle cell disease interferes with physical growth during childhood and early adolescence and that affected children weigh less and are shorter than healthy counterparts. Growth restriction in SCD is complex and multiple factors are likely to contribute, such as the haematological and cardiovascular, social factors, endocrine function and metabolic and nutritional status. The current prevalence of malnutrition in patients with SCD and the relationship between Hb levels and nutritional status are not known. Hence, this study will help fill this knowledge gap.

Aim of the study: To determine prevalence, factors and complications associated with malnutrition among patients with SCD in Dar es Salaam Tanzania.

Methodology: This was a hospital-based cross-sectional study carried out at the Muhimbili National Hospital (MNH) and Temeke Hospital in Dar Es Salaam, Tanzania, over a period of 6 months. Non-probability consecutive sampling technique was used to recruit 246 children and adolescents with SCD, aged 6 months to 15 years, who routinely attend haematology clinics. Questionnaire was used. Nutritional status was assessed using WHO scores anthropometric indices; weight for height, height/length for age. Blood samples were also collected to measure vitamin B12 and Hb level. Analysis was done using SPSS version 23.

Results: The overall prevalence of malnutrition among patients with SCD was 59.7% that is undernutrition was 58.2% and while obesity was 1.2%.

Majority of patients with SCD and malnutrition had a haemoglobin level of 6.50-7.9 g/dL. In this study, majority of the patients with SCD and malnutrition had normal Vitamin B_{12} levels except for 2% that had low levels.

Conclusion: This study found that SCD is associated with malnutrition and growth retardation. And as the age increases the children were at more risk of being underweight as the study supports underweight was more common in children above 5 years of age. The study established that majority of patient with SCD and malnutrition had haemoglobin level that ranged between 6.50-7.9 g/dL. The study also established that majority of patients with SCD and malnutrition had normal levels of Vitamin B_{12}.

Recommendations: Anthropometric measurements to be part of clinical practice of patients with SCD who attend haematology clinic so that they are noted early with malnutrition and intervention is made early either through supplementation of macro and micro nutrients or through nutritional educational.

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LIST OF ABBREVIATIONS

BMI	Body Mass Index
BMT	Bone marrow transplantation
BT	Blood transfusion
CHO	Carbohydrate
Hb	Hemoglobin
HU	Hydroxyurea
MMA	Methylmalonic acid
MNH	Muhimbili National Hospital
MUAC	Mid upper arm circumference
MUHAS	Muhimbili University of Health and Allied Sciences
RDA	Recommended daily amount
REE	Resting Energy Expenditure
SCA	Sickle cell anemia
SCD	Sickle cell disease
SS	Homozygous sickle cell
WHO	World Health Organization
VOC	Vaso occlusive crises

DEFINITIONS OF TERMS

Anabolism is the process whereby nutrients are build up (1,2)

Anaemia in sickle cell disease (SCD) is defined as haemoglobin (Hb) less than 2 g/dl from the steady state Hb, with the presence of symptoms and signs of anaemia, anaemia can either be due to infection, increased hemolysis or poor dietary intake.

Catabolism is the breakdown of nutrients(1,2)

Erythropoiesis is the process of producing red blood cell(1)

Hypermetabolism is a state of high caloric demand with an increased rate of catabolism and anabolism(1)

Malnutrition refers to deficiencies, excesses or imbalances in person's intake of energy and/ or nutrients. The term malnutrition covers 2 broad groups of conditions. One is 'undernutrition'- which includes stunting (low height for age), wasting (low weight for height), underweight (low weight for age) and micronutrient deficiencies or insufficiencies (a lack of important vitamins and minerals)(3)

Patients as per this study is referred to children and adolescent of up to fifteen years.

Sickle cell anemia (SCA) or HbSS is a genetic blood disease due to the presence of an abnormal hemoglobin, namely hemoglobin S and it results from the substitution of valine for glutamic acid in the β-globin chain of the hemoglobin molecule(4)

Sickle cell disease (SCD) is a group of inherited red blood cell disorders that's affects hemoglobin, the molecule that delivers oxygen throughout the body and it denotes all genotypes containing at least one sickle gene in which HbS makes up at least half the hemoglobin present.Eg HbSS, HbS/b-0 thalassemia, HbSC, HbS/b + thalassemia(4)

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Epidemiology

Sickle cell disease (SCD) is one of the common chronic genetic blood disorders with variable clinical presentations. The disease occurs as a result of a point mutation in the β-globin chain of Hb molecule; where a non-polar amino acid, valine, is substituted for a polar amino acid, glutamic acid(4). In a reduced oxygen environment, the single amino acid substitution results to polymerization of haemoglobin molecules resulting in sickle shaped red blood cells. The main consequences resulting from this abnormality are vaso-occlusive crisis (VOC) and increased haemolysis. VOC may lead to pain, tissue, bone, and organ damage while chronic haemolysis may lead to anaemia (5).

It is approximated that about 4% (2–8%) of the world population carry an abnormal haemoglobin gene, SCD being the most common form of haemoglobinopathy (6).

Africa has the highest burden of SCD up to 75% of the 300,000 global births of SCD occur per year and childhood mortality remains high, ranging between 50 and 90%. Tanzania is amongst the 5 countries in the world with the highest estimated number of newborns with SCD a year (Nigeria 85,000, Democratic Republic of Congo 42,000, India 38,000; Tanzania 11,000 and Uganda 10,000 (7).

Sickle cell disease and malnutrition

It is generally accepted that homozygous sickle cell Anemia (SS) interferes physical growth during childhood and early adolescence and that affected children weigh less and are shorter than healthy counterparts (8). Nutrition is reported to impact many chronic health conditions associated with SCD, including chronic baseline inflammation, painful crisis and increase in occurrence of stroke, particularly in young children (9,10). Past studies have documented that SCD leads to a state of malnutrition and poor growth. One hypothesis is that of hypermetabolism. In hypermetabolism there is an increased rate of catabolism and anabolism. In SCD, however, there is a shift toward increased catabolism, leading to high nutrient demand

(1,2). Hibbert and colleagues (2006) reported that increased myocardial energy demand, along with increased production of proinflammatory cytokines, is associated with increased resting energy expenditure (REE), a surrogate marker of a state of hypermetabolism. In the last few years, many studies have documented the presence of micro- and macronutrient deficiency among individuals with SCD and their possible association with immunologic, nutritional and growth impairment (11–14).

Factors associated with malnutrition in SCD

Growth impairment in sickle cell disease (SCD) is complex and multiple factors are likely to contribute, such as the haematological and cardiovascular, social factors, endocrine function and metabolic and nutritional status (8). Growth rate is inversely related to the degree of anaemia and is likely to be associated with deficiency of specific nutrients as well as inadequate nutrient intake, reduced absorption and increased losses or utilization (6,15). Reduced growth and delayed development are common in children with SCD to the extent that some researchers are advocating the use of modified growth charts when monitoring their nutritional state(16). Usually, these patients experience a progressive decrease in growth velocity up to adolescence. In addition, they have a delay in bone maturation, epiphysis fusion during puberty and sexual development (8). In Africa, where dietary intakes are suboptimal for many populations, it was hypothesized that nutrition is a crucial modifiable risk factor for SCD morbidity and that poor nutrition status is associated with increased mortality and morbidity (17).And also vitamin B 12 as being one of the micronutrients patients with SCA may suffer from unrecognized vitamin B 12 deficiency (18).

In Tanzania the previous studies demonstrated the outcome and complications of malnutrition in patients with sickle cell disease but factors associated with malnutrition were not addressed.

1.2 Problem statement

SCD patients are prone to malnutrition and poor growth. Malnutrition is one of the major cause of morbidity and mortality by worsening anemia and predisposing SCD patient to infection. The major causes of mortality and morbidity have been studied in settings outside and inside Africa and markedly reduced by a range of interventions (19).

Factors associated with malnutrition in SCD patients is still a challenge despite many studies in nutrition status in SCD children.

The paucity of data regarding factors associated with malnutrition in this cohort of patients with sickle cell disease in Tanzania prompted the choice of this research. Finally, the importance of finding a nutritional remedy lies in the fact that currently available approaches for managing SCD are either too expensive and not readily accessible (e.g., BMT) or have side effects, such as alloimmunization and iron overload in the case of BT and potential risk for malignancy in the case of hydroxyurea. Furthermore, it will be essential for more studies to adopt a nutritional approach as a part of the management modality for SCD in the light of the fact that more than two-thirds of the patients with SCD live in areas of the world with low socioeconomic status such as our country Tanzania and have little to no means of accessing the aforementioned management approaches.

1.3 Conceptual framework

In this study, independent variables are demographic and anthropometric measurements, patients' family, dietary intake and supplementations and laboratory results. The dependent variable is nutritional status.

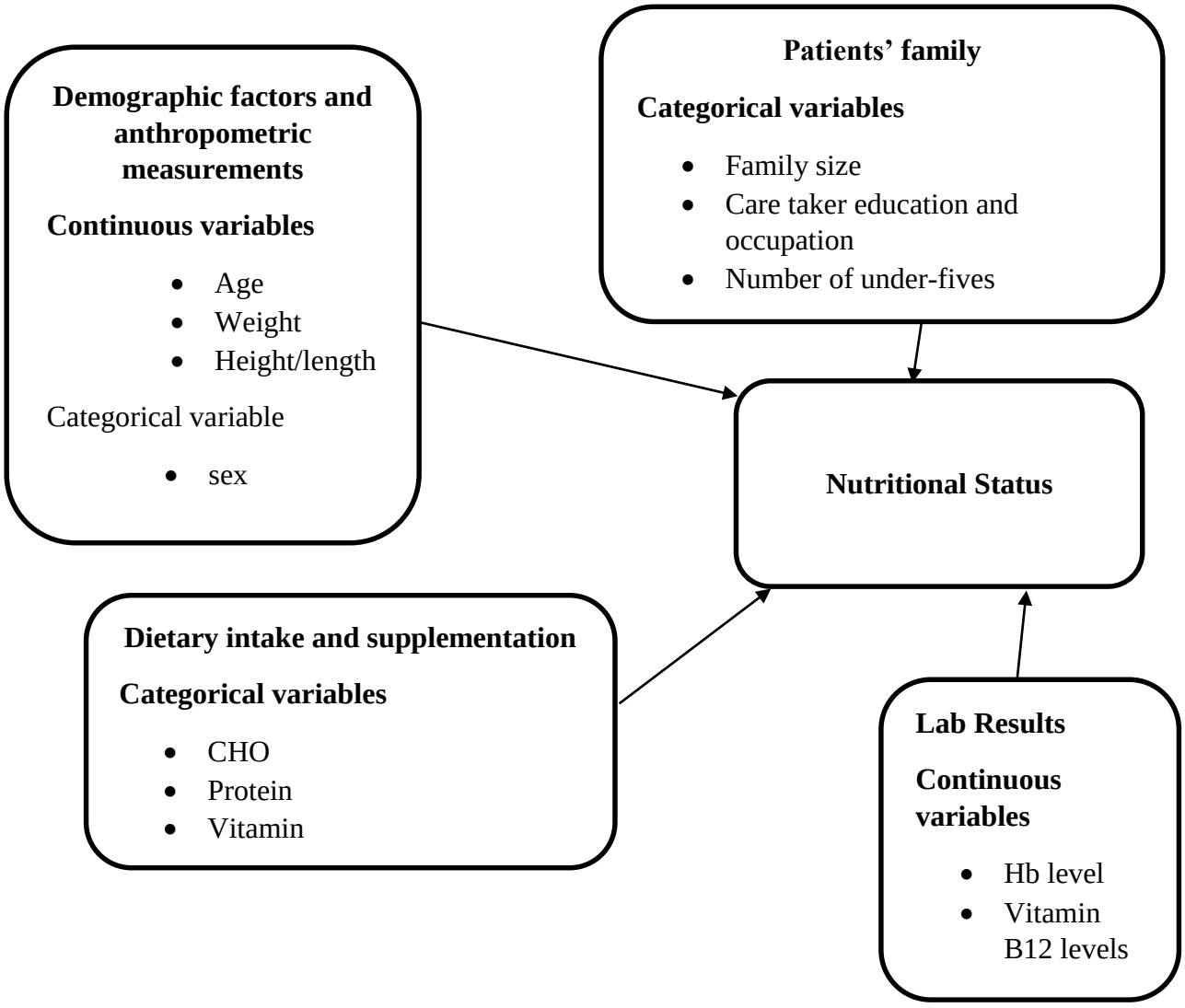

Figure 1.Conceptual framework

1.4 Rationale of the study

The information obtained from this study will provide us with current prevalence of malnutrition in patients with SCD and that will add knowledge to the general population. Moreover, the findings of this study will fill in the gap of knowledge on factors associated with malnutrition and nutrition status in patients with SCD.

1.5 Research questions

1. What is the prevalence of malnutrition in patients with SCD at Dar es Salam, Tanzania?
2. What are factors and complications associated with malnutrition in patients with SCD?
3. What is the level of haemoglobin in patients with SCD and malnutrition at Dar es Salaam, Tanzania?
4. What is the level of vitamin B_{12} in patients with SCD and malnutrition at Dar es Salaam, Tanzania?

1.6 Objectives of the study

1.6.1 Broad objectives

To determine the prevalence, factors and complications associated with malnutrition in patients with SCD in Dar es Salaam, Tanzania.

1.6.2 Specific Objectives

1. To determine the nutritional status of patients with SCD
2. To determine the level of haemoglobin in patients with SCD and malnutrition
3. To determine vitamin B_{12} levels in patients with SCD and malnutrition

CHAPTER TWO

2.0 LITERATURE REVIEW

Sickle cell disease (SCD) is one of the chronic genetic blood disorders with variable clinical presentations. The disease occurs as a result of a point mutation in the β-globin chain of Hb molecule; where amino acid, valine, is substituted for glutamic acid (4). Homozygous sickle cell anemia (SS) interferes physical growth during childhood and early adolescence and that affected children weigh less and are shorter than healthy counterparts (8). Nutrition is reported to impact many chronic health conditions associated with SCD, including chronic baseline inflammation, painful crisis and increase in occurrence of stroke, particularly in young children (9,10).

In some of the previous studies done on the nutrition status among patients with SCD, greatest growth deficits were observed in adolescents and in boys. Independent of age and sex, lower hemoglobin concentration was associated with increased odds of malnutrition in sickle cell patients (17). Sex distribution is similar 49% being male. However, the proportion of male decrease significantly with age (17).

Reduced intake can result from anorexia, a prominent symptom in affected children even in the absence of infection, and it often precedes a painful crisis by days or weeks (20). At the time of hospital admission, energy intake during acute illness is reduced by as much as 44% of the recommended daily amount (RDA) (SD 9%); during follow-up, intake is closer to 90% of RDA (21). Dietary intakes can be decreased markedly prior to admission and remain sub-optimal for weeks (22). There is evidence that nutrient supplementation can reduce growth retardation. Supplements given by the nasogastric route to SCD children with growth retardation (weight and height ,5th centile) led to a rapid and sustained increase in growth and a reduction of pain crises and episodes of infection (23). Furthermor some studies done found no lipid malabsorption and a normal histological appearance of the intestinal mucosa and submucosa and concluded that inadequate energy intake was responsible for the growth retardation (17).

In Africa, where dietary intakes are sub-optimal for many populations, it was hypothesized that nutrition is a crucial modifiable risk factor for SCD morbidity and that poor nutritional status is associated with high mortality and morbidity. It was described that in anthropometric measurements of nutritional status in a large cohort of Tanzanian SCD patients at enrollment (17). The most immediate determinants of malnutrition are reduced dietary intake and disease which are themselves caused by a number of underlying factors: household food insecurity, poor maternal/child caring practices, and lack of access to basic health services including lack of safe water supply and unhealthy living environment such as open defecation (24,25). In turn, these underlying causes themselves are influenced by economic, political, and sociocultural conditions; national and global contexts; capacity, resources, environmental conditions, and governance (26).

Growth rate is inversely related to the degree of anemia and is likely to be associated with deficiency of specific nutrients as well as inadequate nutrient intake, reduced absorption and increased demand or losses (6,15). In SCD there is increased destruction of these cells creates a need for increased erythropoiesis, which leads to increased protein turnover and thus increased energy demand (1). Furthermore, high hemolysis results in reduced red cell count and anemia. As a compensatory mechanism to maintain tissue oxygenation, the heart rate is increased, leading to increased myocardial energy demand (1) with the net effect of an increase in myocardial energy requirement and thus total energy requirement. Patients with SCD have a series of micronutrient deficiencies: vitamins A, B_2, B_6, B_{12}, C, D and E, folic acid, iron, calcium, magnesium and zinc (27). It has been suggested that a proper nutrition could improve body composition, especially lean mass, and have a positive impact on SCD morbidity and mortality (28). There was a study done in the United states of America which showed cobalamin deficiency, 2 (6.9%) in the SCD group and 2 (3.5%) in the non-SCD group (29). In this study they have demonstrated that serum cobalamin is lower in SCD patients and most SCD patients in this study appeared to have adequate cobalamin status as evident by normal MMA and homocysteine concentrations but true cobalamin deficiency does exists in a small fraction (29). In addition to studies on Vitamin B_{12} there was a study done which showed that 43.5% of SCD had low vitamin B_{12} serum levels without macrocytosis or segmented neutrophils.

Hence it was concluded that may patients with SCA may suffer from unrecognized vitamin B_{12} deficiency (18).

According to World Health Organization (WHO), wasting, stunting and underweight are defined as Z-scores less than -2 standard deviations of weight for height, height for age and weight for age respectively (30). Wasting and stunting reflect acute and chronic exposures for nutritional deficiency, respectively. In addition, underweight reflects both acute and chronic exposures for nutritional deficiency (31).

Prevalence of malnutrition in patients with SCD

Globally the prevalence of underweight in American children with SCD was 41% for moderate and 25% for severe under-nutrition, with a prevalence of wasting of 11%. This was a study done by Henderson et al on prevalence of impaired growth in children with homozygous sickle cell anaemia." (32).

Another previous study was done in Brazil and Nigeria which was a comparative study of the growth and nutritional status of school-aged children with SCD. The study showed that the proportion in both centers was 23.5%, more Nigerians 29.5% vs 18.3% were malnourished, stunted 12.6% vs 3.7% (33). The study concluded that undernutrition is still prevalent among Brazilian and Nigerian children with SCD and that Nigerian children were thinner and had a reduced linear growth for age. This observation justifies the continued need for proper nutritional care for patients with SCD (33). Also this study showed a need of more studies to determine a systematic plan on nutritional intervention and exercise regimens for patients with SCD apart from HU therapy (33).

Furthermore, a study was done in Ghana in 1996 which reported that 44% of Ghanaian children were stunted and adolescents and almost all those with SS were underweight, irrespective of height (34).

In addition to that, there was a study done at Princess Marie Louise Hospital, Accra,which showed that children with SCD have low intake of energy and micronutrients particularly calcium and the antioxidant nutrients, vitamin C and E. Age trend showed that meeting nutrient

requirements declined with increase in age and children with the genotype SS had a lower tendency to meet recommended daily allowances for nutrients (35). The prevalence of malnutrition in that study was 38%, with the prevalence of stunting, underweight, thinness, and wasting being 25.8, 20.0, 15.8, and 6.8%, respectively. Child's genotype, (SS), significantly predicted stunting but not underweight (35).

A recent study done in one of the East African countries, Kenya, which involved 15 children with SCD, 20% had severe acute malnutrition. The study concluded that patients with SCD are predisposed to malnutrition hence growth and nutritional status needs to be assessed regularly as part of proper care (36).

And lastly, another study which was done in 2009 here in Tanzania and the prevalence of stunting was 36.2% and wasting 18.4% (17). The findings of the study was that SCD is associated with high prevalence of malnutrition and growth restriction in patients of all age groups but particularly in adolescents (17). Also a need of further investigation on relationship between Hb concentration, nutritional status and severity of disease (17). The current data on prevalence of malnutrition in Tanzania is not known hence a need of another study and also there is no data that is available on the relationship between haemoglobin concentration and nutrition status.

Factors associated with malnutrition in patients with SCD

Globally, in previous study which was done which compared the nutritional and some clinical parameters of two cohorts of children with SCD from Ilesa, Nigeria and São Paulo, Brazil, in order to examine the probable role of environmental factors on SCD phenotypes. Higher occurrences of underweight and short stature were observed among Nigerian children with SCD, while the occurrence of overweight or obesity was higher among the São Paulo cohort. These differences may be due to factors such as timing of diagnosis, unequal access to comprehensive care, dietary differences, climate and actual duration of exposure to sunlight.

Previous study done in Ghana, 100 children with SCD were involved in the study. In the study, dietary intakes of the children with SCD were compared with age-specific RDA for normal

children. Generally, in this study it was found poor dietary among the study participants and this study is consistent with other studies done by Hyacinth et al (2013), who reported that malnutrition in children with SCD in most third world countries is mostly associated with inadequate diet(37,38).

In addition to that a study done in Congo and published in the year 2017 whereby there were only a little explanation on factors associated with malnutrition which were phenotypic polymorphism due to haplotype, genetics factors , fetal haemoglobin level, specific nutrient deficiencies, and environmental factors(39).

Another previous study that was done in Africa and this was done in East Africa in Uganda in 2019 the findings of the study was that older age (10-12 years) and living in a female headed household were significantly associated with undernutrition. In this study about 20.2%, 11.4% and 13.7%(40).

The current data on factors associated with malnutrition in SCD is not available hence by doing this study will have the current knowledge.

The level of Haemoglobin in patients with SCD and malnutrition

Globally a previous study that was conducted in Italy in 2016 concluded that low body weight and BMI can negatively affect total haemoglobin levels, one of the most important parameters to define SCD severity (41).

A study done in East Africa showed that all of the children with SCD who were malnourished were anemic with an average haemoglobin of 7.1 +/-1.59 g/dl(36). Little is known on level of anemia in relation to SCD with malnutrition in other African countries apart from the East African study to be precise the study done in Kenya. The data on anemia in malnutrition patients with SCD in Tanzania is not yet known.

The level of Vitamin B_{12} in patients with SCD and malnutrition

Globally a study was done in the United states of America which showed cobalamin deficiency, 2 (6.9%) in the SCD group and 2 (3.5%) in the non-SCD group(29). In this study they have

demonstrated that serum cobalamin is lower in SCD patients and most SCD patients in this study appeared to have adequate cobalamin status as evident by normal MMA and homocysteine concentrations but true cobalamin deficiency does exists in a small fraction(29). In addition to studies on Vitamin B_{12} there was a study done which showed that 43.5% of SCD had low vitamin B_{12} serum levels without macrocytosis or segmented neutrophils. Hence it was concluded that many patients with SCA may suffer from unrecognized vitamin B_{12} deficiency (18).

However, none of the studies done on levels of Vitamin B_{12} in SCD associated it with malnutrition and in Africa and East Africa no data is available on levels of vitamin B_{12} in Patients with SCD and malnutrition.

The improvement in the survival rate and overall health of children with SCD has been attributed in part to early diagnosis of SCD, penicillin prophylaxis, immunization, stroke prevention, administration of hydroxyurea and chronic BT(19). Reports from developing countries indicate that these measures are also being increasingly used in the population with SCD (42,43).

CHAPTER THREE

3.0 Methodology

3.1 Study Design

This was hospital-based cross-sectional analytical study. There was a use of questionnaires to get data, and also because of limited time that is 6 months, in cross-section studies only prevalence of the disease and/or exposure is done at one moment in time.

3.2 Study Area

This study was conducted at the outpatient and inpatient department of Muhimbili National Hospital (MNH) and Temeke in Dar Es Salaam, Tanzania. MNH is a national hospital and provides services to all Tanzanians and non-Tanzanians with all forms of medical conditions including SCD. It is a teaching hospital located in Ilala district with bed capacity of about 1500. The sickle cell clinic is held once a week in Pediatric and adult. All patients with SCD are scheduled for regular appointments every one or three months depending on patients' condition. On average, about 50 patients are seen at the clinic every week at Pediatric including newly diagnosed cases and 10 at adult clinic. The mortality rate of patients with SCD is about 2% at MNH. Temeke is a Regional hospital in Temeke district. An average of 20-40 patients with SCD attend clinic at Temeke hospital in a week and the clinic is held twice in a week. The mortality rate of patients with SCD at Temeke is about 1.5 %.

3.3 Study Duration

The study was conducted over a period of 6 months from October 2020 to March 2021.

3.4 Study Population

This study included children and adolescents aged 6 months–15 years who had been diagnosed with SCD and routinely attended the haematology clinics or admitted at MNH and Temeke hospitals.

3.4.1 Inclusion criteria

- All patients with SCD, aged 6 months–15 years.
- All the study participants were clinically stable at the time of recruitment.
- Parents of the children with SCD were informed and consent was obtained from them and assent was obtained from children ten years and older.

3.4.2 Exclusion criteria

- Patients with SCD taking medications known to affect growth or nutritional status such as glucocorticoid therapy were not included in the study.

3.5 Sample Size

- $n = \frac{Z^2 \times P(1-P)}{\varepsilon^2}$
- $n = 365$
- z: percentage point of normal distribution corresponding to the level of confidence (95% 0f C.I (Confidence Interval) =1.96)
- p: is the expected prevalence that can be obtained from some studies or pilot study. For the case of my study I used prevalence of 38% which is the prevalence of malnutrition in a study done at Accra by Isaac Boadu etal, 2018(35).
- ε: margin of error 5% which is corresponding to the effect of size
- Therefore, from the above formulas the required sample size is 365 patients
- For a smaller population
- n from the pilot study done from October to December 2019 is 750
- N calculated is 365
- Adjusted sample size formula $n = \frac{N \times n}{N+n-1}$
- $N = 365 \times 750 / 365 + 749$
- n = 246

3.5.1. Sampling Method

Non probability convenient sampling technique was used where all patients with SCD who met the inclusion criteria during the study period were recruited until the required sample was reached. Non-probability sampling method, because it is the most applicable and widely used method in clinical research. In this method, the investigators enroll subjects according to their availability and accessibility. Therefore, this method is quick, inexpensive, and convenient. It is called convenient sampling as the researcher selects the sample elements according to their convenient accessibility and proximity (44).

3.6 Data Collection

3.6.1 Data collection tools

Data collection tools that was used included tape measure, height/length board that was available in pediatric wards was used, weighing machine, WHO z scores chart for girls and boys, 2 vacuum blood test tubes with a purple and green/red tops for blood sample. A structured questionnaire and a pen for filling the information.

3.7.2 Data collection procedure

The investigator attended inpatient and outpatient pediatrics departments and the patients who met inclusion criteria were recruited. All patients who met inclusion criteria were informed about the study and requested to participate, since they were below 18 years, parents or caretakers were asked to consent on their behalf and those who agreed to participate signed the informed consent.

A thorough history was taken from each patient who consented for the study. Information regarding the socio-demographic data, use of insurance, parents level of education, economic status collected using a pretested structured questionnaire. Feeding history was established. Unbalanced diet was considered when one or more of the major groups was missing in the diet. The major groups considered was CHO, proteins, fats, minerals and vitamins and water

Nutrition was assessed using WHO scores anthropometric indices: - weight for height/length, weight for age for children aged under five years and BMI for children above five years 15 years Height/length was measured to the nearest cm using height or length board. For children who had not started to stand were lied down on the length /height board and the length was recorded. And for the ones who stood up, stood along the board and height was recorded. Weight was measured to nearest 0.1 kg using a weighing machine and was measured using standardized techniques. WHO Z-scores for height-for-age (HAZ) and weight-for-height was determined from the chart up to 60 months and body-mass-index for age (BMI) was calculated for patients aged over 60 months. Levels of malnutrition (stunting, underweight and wasting) was defined as Z-scores of less than -2 but more than -3 for moderate and less than -3 for severe. HAZ scores determined the severity of stunting, underweight and BMI, wasting. This was done by the principal investigator.

And for micronutrients blood sample about 2 milliliters (mL) was collected from the patients with SCD to measure Vitamin B12 levels only. Hb levels was also be measured by taking 2 mL of blood sample from the patients for investigation. About 4 mL of blood was taken from each patient and 2 mL was kept in purple stopper bottle for Hb measurements and 2mL in green/red stopper for vitamin B12 levels. Laboratory investigations was performed by lab personnel and principal investigator. The Hb level was determined by performing a full blood count using a CELL- DYN-3700 hematology analyzer and the serum vitamin B_{12} levels were done using ARCHITECT plus ci4100b analyzer. Standard procedures were followed during all the laboratory procedures and the quality of vitamin B_{12} levels and haematology analyzer was checked by running quality control samples along with the patients sample.
All the information and laboratory findings was filled in a structured questionnaire.

3.8 Data analysis

Data from the questionnaire was coded and analyzed using SPSS (Statistical Package for Social Sciences) software version 23. The Mean, Standard Deviation, Frequency, Prevalence and percentage were used to summarize variables. Continuous variables was expressed as the mean

+/- SD or as median and interquartile ranges. Dependent variables were associated with independent variables. Comparison of categorical variables between groups was performed using chi-square. Logistic regression analysis was used to determine factors (complications) associated with malnutrition in patients with SCD and binary variables. Univariate logistic regression analysis was performed. Bivariate correlations were assessed using Pearson's correlation coefficient to determine factors (complications) associated with malnutrition in patients with SCD and continuous variables. P-value of less than 0.05 was considered statistically significant.

3.9 Ethical considerations

Application for Ethical approval was obtained from the Ethics and Research Committees of MUHAS before commencement of the study. Permission to conduct the study was requested from Executive Director of MNH as well as medical officer in charge of Temeke hospital through the heads of Department of Pediatrics in each hospital. Also, written informed consent was obtained from all study participants. The right to withdraw from the study was explained to the patients and their names were kept confidential.

Patients identified to have severe malnutrition were linked to care in the respective hospitals and results obtained was shared with doctors caring for these patients to inform their caretakers. However, the community from which these subjects come from will benefit from the knowledge generated from the study. The study has contributed to add knowledge on importance of nutritional management of patients with SCD

3.11 Mitigation includes

Patients whose information on a particular variable was incomplete were excluded in the analysis of that particular variable. Nature of the study was cross - sectional analytical that helped reduce the information bias.

CHAPTER 4

4.0 RESULTS

In this study 300 patients with clinical diagnosis of SCD were recruited, 246 were eligible hence enrolled.

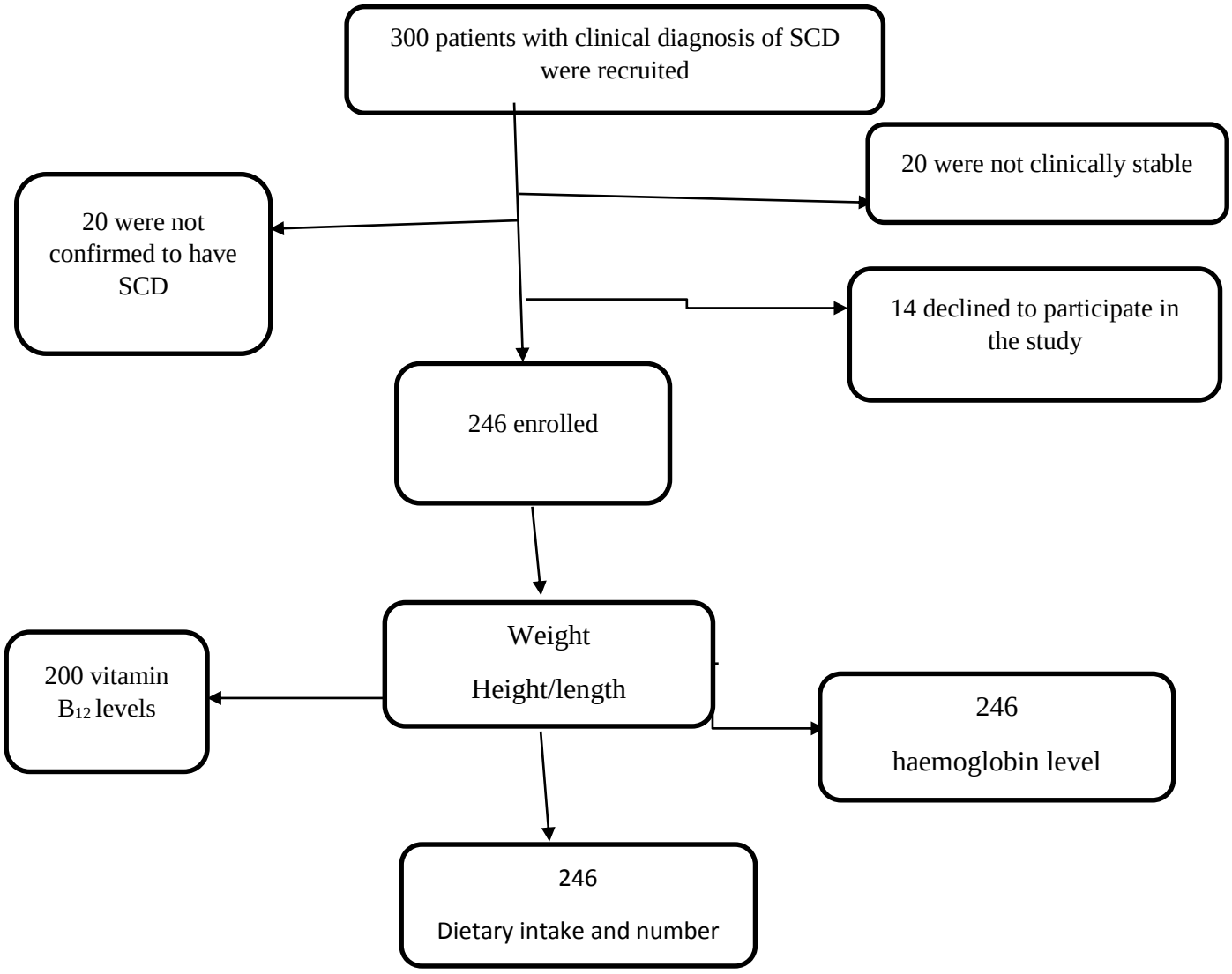

Figure 2. Flow chart

4.1 Description of study participants

Among 246 patients with SCD 146(59.3%) were male and 100(40.7%) were female. Majority of the study participants age ranged between 24 months to 12 years (preschools and children) (figure 2), youngest one being 6 months and oldest one being 15 years. Majority of the children had health insurance 167(67.9%) had NHIF and 8(3.3%) had other health insurances which were Community health fund (CHF), Jubilee. Only 79(32.1%) of the patients were using hydroxyurea while 167(67.9%) were not using hydroxyurea. The ones on hydroxyurea 44(55.9%) were on hydroxyurea for less than 6 months' duration, 29(36.7%) were on it for a duration of 6 months to year and 6 (7.4%) were on hydroxyurea for more than a year. Almost all the fathers of the patient with SCD earned a living and 54.9 % of the mothers had only standard seven level of education and some that is 8.9% had no formal education.

Table 1. Baseline characteristics

Characteristics	**N=246** **No (%)**
Age Mean	2.71
Standard Deviation	0.738
Age Distribution	
Infants (1-<2 Years)	13 (5.3)
Pre-schools (2 years-6 Years)	64 (26.01)
Children (6-12 Years)	130 (52.8)
Adolescents (13-15 Years)	39 (15.9)
Biological Sex	
Male	146 (59.3)
Female	100 (40.7)
State of Insurance	
NHIF	167(67.9)
Not Insured	71(28.9)
Others CHF, Jubilee	8(3.2)
Use of Hydroxyurea	No (%)
Yes	79 (32.1)
No	167 (67.9)
Duration of hydroxyurea use	
< 6months	44(55.9)
6months to 1 year	29(36.7)
>1 year	6(7.4)
Occupation status of mother	
Earns a living	165(67.1)
Does not earn	80(32.5)
Occupation status of father	
Earns a living	245(99.6)
Does not earn	1(0.4)
Level of education of caretaker/mother	
No formal education	22(8.9)
Std 7 leaver	135(54.9)
Form 4 leaver	60(24.4)
Form 6 leaver	3(1.2)
Higher education	26(10.6)

Age distribution for the majority of patients in this study was 6 to 12 years and it was 52.8% as shown in the figure 3 below

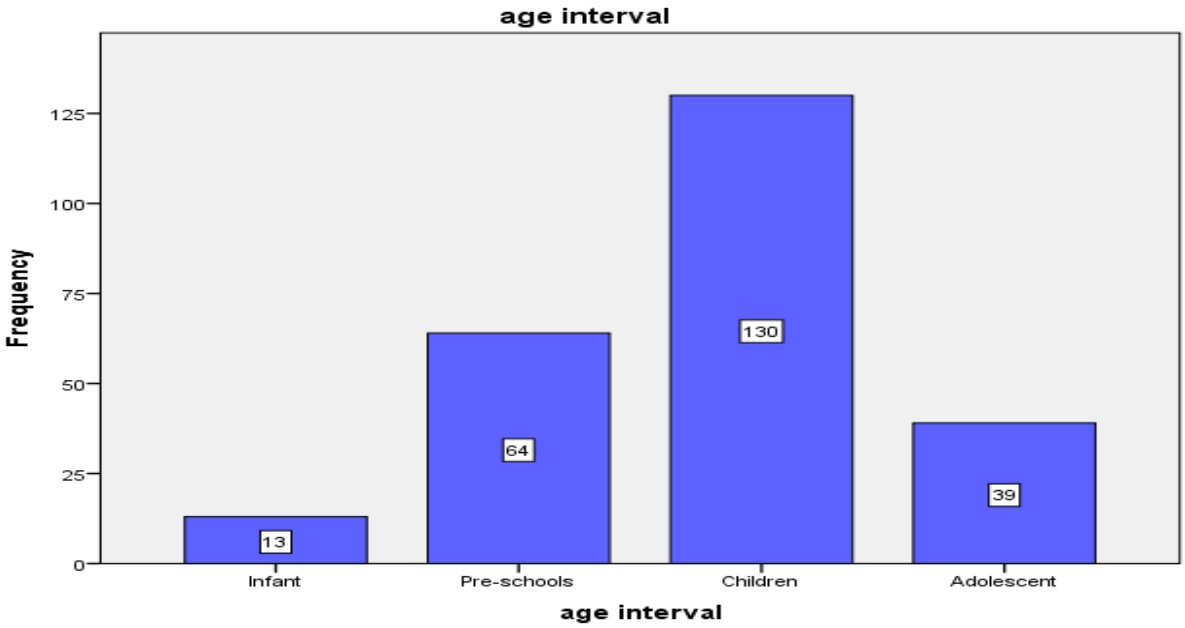

Figure 3.Age interval in year's bar graph

4.2 Prevalence of malnutrition among the patients with SCD

The overall prevalence of malnutrition was 59.7% that is undernutrition was 58.5% and obesity was 1.2%. The prevalence of stunting, wasting, both stunting and wasting, obesity (<5 years) and underweight (> 5 years) was 0.4%, 2.8%, 10.6%, 1.2% and 44.7% respectively.

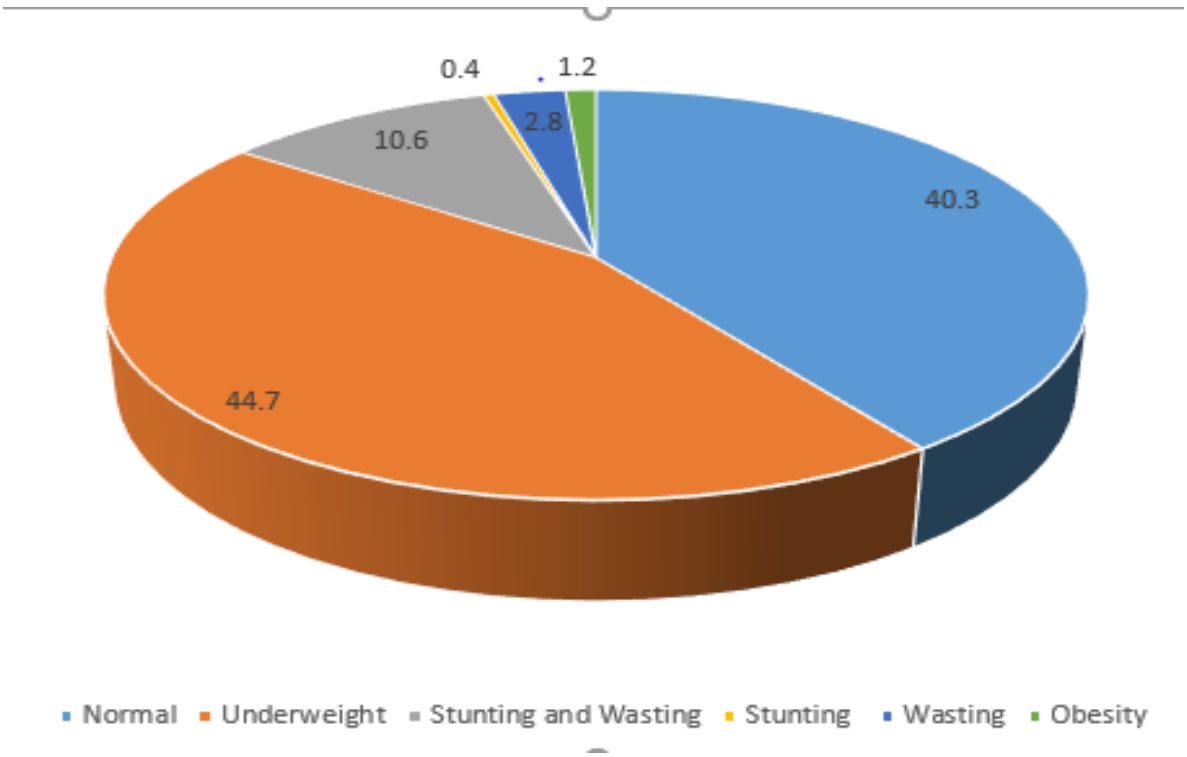

Figure 4. Prevalence of malnutrition

Children five years or older were more malnourished that is 110(44.7%), while children under five years of age had good nutrition status 40(16.4) as shown by figure 4.

Table 2. Frequency of Nutrition status with age interval in months.

Status		**Above 5 years (%)**	**Below 5 years (%)**	**Total (%)**
BMI(Kg/m2)	Under weight	110(44.7)	-	110 (44.7)
	Normal	59(24.0)	-	16 (24.0)
WHO score for Malnutrition	Stunting	-	1 (0.4)	1 (0.4)
	Wasting	-	5 (2.8)	5 (2.8)
	Normal	-	40 (16.3)	40 (16.3)
	Obese	-	3 (1.2)	3 (1.2)
	Wasting & Stunting	-	26 (10.6)	26 (10.6)
Total		169 (68.7)	77 (31.3)	246 (100)

The table 2 above shows that children above 5 years were more malnourished 44.7% while children under five years only 15 % were malnourished.

4.3 Factors associated with malnutrition

1. In this study a total of 79(32.1%) children used hydroxyurea. Majority of children who were in the groups underweight and both stunting and wasting and with normal nutrition status were not using hydroxyurea as shown in the table below

Table 3.Cross tabulation of Nutrition status and use of hydroxurea

		Use of hydroxyurea Yes(%)	No(%)	Total
BMI	Underweight	36(32.7)	74(67.3)	110
	Normal	25(42.4)	34(57.6)	59
WHO score	Stunting	1(100)	0(0)	1
For	Wasting	1(85.7)	6(14.3)	7
Malnutrition	Normal	11(27.5)	29(72.5)	40
	Obese	0(0)	3(100)	3
	Wasting & Stunting	5(19.2)	21(80.8)	26
	Total	79(32.1)	167(67.8)	246

2. In this study in children above 5 years 60% of children in the underweight group had family size of more than four people (large size) and it was not different from the group with normal nutrition status which was 55.9%. And in children below five years majority of them irrespective of nutrition status lied in family size of 4 people (small size) as shown in the table 4 below.

Table 4. Cross tabulation of Nutrition status and family size

		Family Size		
		1-4(%)	>4(%)	Total
BMI	Underweight	44(40)	66(60)	110
	Normal	26(44.1)	33(55.9)	59
WHO score	Stunting	1(100)	0(0)	1
For	Wasting	5(71.4)	2(28.6)	7
Malnutrition	Normal	28(70)	12(30)	40
	Obese	2(66.7)	1(33.3)	3
	Wasting & Stunting	14(53.8)	12(46.2)	26
	Total	120(48.8)	126(51.2)	246

3. In this study majority of the mothers' level of education was standard seven leaver and it was irrespective of the nutrition status of the study participants as shown in the table below

Table 5. Cross tabulation of nutrition status and level of education of mother/caretaker.

		Level of	**education**	**of**		**mother**	
		No formal education	Std 7 leaver	Form 4 leaver	Form 6 leaver	Higher education	Total
BMI	Underweight	15	71	20	0	4	110
	Normal	3	28	20	0	8	59
WHO	Stunting	0	1	0	0	0	1
Score	Wasting	1	4	1	0	1	7
For	Normal	2	14	11	3	10	40
malnutrition	Obese	0	1	1	0	1	3
	Wasting & Stunting	2	16	6	0	2	26
Total		23	135	59	3	26	246

4.4: To determine the level of haemoglobin in patients with SCD and malnutrition

In this study, the group of children who were underweight majority of them had haemoglobin 6.5-7.99g/dL (53.6%), which was followed by 8.0-9.49/dL (24.4%) and < 6.5 which was 20%. In the group of wasting 57 % had 8-9.49g/dL and 43% had 6.5-7.99g/dL. In the group with both wasting and stunting 46.2% had haemoglobin of 6.5-7.99g/dL and 30.8% had haemoglobin 8.0-9.49 g/dL, <6.5g/dL and 11-13g/dl was 11.5% respectively and hence majority of children with SCD had haemoglobin level of 6.50-7.99 g/dL. The body mass index with level of hemoglobin is statistically significant as shown in table 6 below were the Pearson value is 0.003

Table 6. Cross tabulation of nutrition status and Haemoglobin.

Status		Level of Hemoglobin - g/dL					
		<6.5 (%)	**6.5-7.9(%)**	**8.0-9.49 (%)**	**9.5-10.9 (%)**	**11-13(%)**	**P-value**
BMI	Under – weight	22 (20.0)	59 (53.6)	27 (24.5)	2 (1.8)	0 (0.00)	
	Normal	2 (3.4)	20 (33.9)	30 (50.8)	7 (11.9)	0 (0.00)	0.003
WHO score Malnutrition	Stunting	0 (0.00)	0 (0.00)	1 (100)	0 (0.00)	0 (0.00)	
	Wasting	0 (0.00)	3 (42.1)	4 (57.1)	0 (0.00)	0 (0.00)	
	Normal	1 (2.5)	14 (35.0)	16 (40.0)	7 (17.5)	2(5.0)	
	Obese	0 (0.00)	2 (66.7)	1 (33.3)	0 (0.00)	0 (0.00)	
	Wasting & Stunting	3 (11.5)	12 (46.2)	8 (30.8)	3 (11.5)	0(0.00)	0.836

4.5: To determine vitamin B $_{12}$ levels in patients with SCD with and malnutrition

In this study 2.2% were found to have low levels of vitamin B_{12} in the underweight group and 14.3% was found to have higher levels of Vitamin B_{12} in the group of wasting and stunting. Hence the overall level of low level of vitamin B_{12} from patients with SCD and malnutrition is 2% as shown by the table 7 below. The nutrition and the level of vitamin B_{12} was not statistically significant as shown by the table 7 below.

Table 7. Cross tabulation of nutrition status and level of vitamin B_{12}

Status		Level of Vitamin B12			
		Normal Range "187-883" pg/ml (%)	**Below normal (%)**	**Higher than normal (%)**	**P-value**
BMI	Under weight	88 (97.8)	2 (2.2)	0 (0.0)	
	Normal	47 (97.9)	0 (0.0)	1 (2.1)	0.230
WHO Score status of Malnutrition	Stunting	1 (100.0)	0 (0.00)	0 (0.0)	
	Wasting	6 (85.7)	0 (0.0)	1 (14.3)	
	Normal	32 (100.0)	0 (0.0)	0 (0.0)	
	Obese	3 (100.0)	0 (0.0)	0 (0.00)	
	Wasting & Stunting	18 (94.7)	1 (5.3)	0 (0.0)	0.248

CHAPTER 5

DISCUSSION

In the present study, a total of 246 children with SCD were analysed. Majority of the participants (59.3%) were male a finding consistent with other studies done by Al-Saqladi et al (2010) (45).

In the present study, majority of children's age ranged between 2 to 12 years. And 71.1% of the children in the study were NHIF insured and other insurance funds. And 32.1 % of these children were on hydroxyurea.

Anthropometric measures reflect the nutritional and growth status of children with SCD. Both stunting and wasting occur together in children with sickle disease underlining the chronicity of the disease and the frequent exacerbations of crisis. In the present study children with wasting were shorter than children with normal weight while those with stunting were more likely to be wasted than children with normal height and underweight was found to be 110 (44.7%), both stunting and wasting was 26 (10.6%). Also, from this study wasting alone was 5 (2.8%), stunting was 0.4% (1), obesity was 3 (1.2%). Hence overall prevalence of undernutrition from this present study is 58.5% and obesity is 1.2% making the prevalence of malnutrition 59.7 % in patients with SCD.

Similar findings to a study done by Sharon E Cox et al in 2011 where SCA with the age range of 0.5 to 64 years were enrolled and the findings were that SCA was associated with stunting in 36.2% and wasting 18.4% were the overall prevalence was 54.6% (17).

In contrast to the findings of some other studies, done by Isaac Boadu et al 2018 whereby more than a third (38%) of the study children aged 3 to 12 years were malnourished(46) indicating low prevalence of malnutrition in Ghana one of the African countries and also in this study older children had the tendency to be malnourished compared to younger ones. Also a study done by Christopher I. Esezobor et al 2016 in Nigeria with mean age of 9 +/- 4 years the findings were that wasting was 22.7%, stunting was 11.6% and overweight was 1.7% (36% of malnourished) (47). However, reports from developed countries reports an increasing problem of overweight

and obesity among the population with SCD just as the non-SCD population. Chawla et al observed overweight or obesity in over 20% of children with SCD in the USA (48) in contrast to the findings of the present study were obesity was 1.2%.

The prevalence of malnutrition in Dar es salaam in the population with no SCD is 15% this is very low compared to the findings of the present study of the children with SCD (49).

In the present study, among the group of children who were underweight, majority of them had haemoglobin level 6.5-7.99g/dL (53.6%), followed by 8.0-9.49/dL (24.4%) and < 6.5 which was 20%. In the group of wasting 57% had 8-9.49g/dL and 43% had 6.5-7.99g/dL. In the group with both wasting and stunting 46.2% had haemogobin level of 6.5-7.99g/dL and 30.8% had haemoglobin level 8.0-9.49 g/dL, <6.5g/dL and 11-13g/dl was 11.5% each and hence majority of patient with SCD and malnutrition had haemoglobin level of 6.50-7.99 g/dL which is a low level of haemoglobin and this is due to increased metabolism of micronutrients and hemolysis. Similar finding is seen in the study done by Sharon E Cox et al in 2011 were lower haemoglobin concentration was associated with increased odds of malnutrition in patients with sickle cell disease.

The prevalence of cobalamin deficiency in the general population is variable depending on the age, population studied and the criteria for diagnosis (50). It has been suggested that SCD poses a risk for cobalamin deficiency because of the increased demand from a high turnover of red blood cells (51).

In this study it was found that nutrition status is not associated with the use of hydroxyurea, family size and level of education of the mother in contrary to the review article that suggested that caretakers' level of education is a factor that influences the nutritional status of children and that low educational level of caretaker influences the child nutrition status by affecting the house hold income, which profoundly influences food consumed in a household(52).

In this study 2.2% were found to have low levels of vitamin B12 in the underweight group and this is probably due to increase demand because of ongoing hemolysis and erythrocyte functional vitamin B_{12} depletion, inadequate supply, co-existing folate deficiency or

malabsorption and 14.3% of wasting and stunting group was found to have higher levels than normal of vitamin B_{12} perhaps due to diet rich in these supplements such as meat, eggs. Hence the overall level of low level of vitamin B_{12} from patient with SCD and malnutrition was 2%. The findings were similar to the study by Ajayi et al in 2014 (29) where the prevalence was 6.9% of cobalamin deficiency (29).

The finding is in contrast to the study by AK al-Momen et al in 1995 were by 43.5% had low levels of vitamin B_{12} (50). Though these studies did not establish the level of vitamin B_{12} among the undernutrition children with SCD.

Actually, the present study is the first study to be done to determine the level of vitamin B_{12} in patients with SCD and malnutrition.

CHAPTER 6

CONCLUSION

It is observed from the study that SCD is associated with malnutrition and growth retardation as the prevalence of malnutrition was found to be 59.7%. Nutritional status using anthropometric measures revealed that underweight, wasting and stunting is prevalent in the study participants. And as the age increases the children were at more risk of being underweight as the study supports underweight was more common in above 5 years. Finding more than a half of the study children (58.5%) were undernourished, with older children tending to be more undernourished 45% compared to the younger ones 14%.

The study also established that majority of children with SCD had low hb 6.50-7.99 g/dL.

Furthermore, the study also established that majority of patients with SCD had normal levels of Vitamin B_{12} levels

Limitation:

Funds to be able to measure all the necessary micronutrients- (Zinc, Ca, Mg, Fe, folate, Vitamins A, D, E, B6)

Recommendation:

Anthropometric measurements to be part of clinical practice of patients with SCD who attend haematology clinic so that they are noted early with malnutrition and intervention is made early either through supplementation of macro and micro nutrients or through nutritional educational. Macro and micronutrient supplementation and nutritional education should be added as part of the treatment protocol for children with SCD in developing countries

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Appendices

Appendix I. Informed Consent Form: English Version

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

Consent to participate in a research study

Greetings. I am Dr Evelyne Modestus Banda, a postgraduate student, doing a masters of medicine in hematology at Muhimbili University of Health and Allied Sciences. I am doing a research with the objective of assessment of, prevalence, factors and complications associated with malnutrition in Patients with SCD at MNH and Temeke Hospitals Dar es Salaam

Purpose of the study: To determine the prevalence of malnutrition, factors and complications in patients with SCD.

Participants of the study: All patients with SCD 6 months to 15 years who are clinically stable will participate in the study. Participants will have their body height/length and weight taken. And blood sample will be taken as routinely done for Hb and also additional investigation of levels of Vitamin B12.

Confidentiality: All the participants who will join the study their names will not be required but will be identified by use of number. The information obtained during data collection will be kept under strict locked environment where it is only the researcher will have access and will be destroyed after the dissertation have been submitted and accepted for the award of my postgraduate degree

Risk: No harm is expected to occur because of joining in the study.

Benefits: The results of this research will help to improve the quality of care of these patients.

Right to withdrawal

Joining in this study is completely your choice. You can withdrawal at any particular moment. You can even refuse to respond to any question in the questionnaire or review guide.

Whom to contact

If you have any inquiries about this study, please do not hesitate to

Contact: **Dr. Evelyne Banda**

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I …..... have read the contents in this form. My questions have been answered and I agree to participate in this study.

Signature of participant ……..

Signature of researcher/research assistant…….

Appendix II. Questionnaire: English version

TITLE: PREVALENCE AND FACTORS ASSOCIATED WITH MALNUTRITION IN PATIENTS WITH SCD

PART A: PATIENT'S INFORMATION

SN……. File No: …….. Informant……

1. DOB……. Age …….
2. Sex
    a) Male
    b) female
3. Residence
    a) Kinondoni
    b) Ilala
    c) Temeke
    d) Other place
4. State of Insurance
    a) NHIF
    b) AAR
    c) Not insured
    d) others mention
5. Family members
    a) 1-4
    b) ≥ 5
6. Number of children in the family
    a) one
    b) two
    c) three
    d) more than three

7. Number of under-fives
    a) One
    b) Two
    c) Three
    d) None
8. Occupation status of mother/caretaker
    a) Earns a living
    b) Does not earn
9. Occupation status of father/caretaker
    a) Earns a living
    b) Does not earn

PART B: ATHOPOMETRIC MEASUREMENTS

10. MUAC…….cm
11. Body weight…….kg
12. Height/length…….cm
13. Weight/height
14. Weight/Age
15. BMI
16. Status of malnutrition
    a) Stunting
    b) Wasting
    c) Normal
    d) Obese
    e) Wasting and stunting

PART C: FACTORS ASSOCIATED WITH MALNUTRITION

17. Level of education of caretaker/mother

    a) Not educated

    b) std 7 leaver

    c) form 4 leavers

    d) form 6 leaver

    e) higher education

18. Diet in last 24 hours

    a) Protein, vitamin, CHO, mineral

    b) CHO, Vitamin

    c) CHO, protein

19. Number of meals in a day

        a) 2

        b) 3

        c) 4

PART D: COMPLICATIONS

20.Level of Hb…….

21.Level of Vitamin B12

a) Normal range(187-883pg/mL)

b) below normal

c) Above normal

PART E: USE OF HYDROXYUREA

22. Does the patient use HU

    a) Yes

    b) No

23.For how long?

    a) <6months

    b) 6 months to one year

    c) >one year

Appendix III. Informed Consent Form: Swahili Version

Salaam, mimi ni Dr Evelyne Modestus Banda, mwanafunzi wa shahada ya uzamili ya udaktari, Idara ya magonjwa ya damu, chuo kikuu cha Afya Muhimbili. Nafanya utafiti Kuangalia kiwango, sababu na athari za utapiamlo kwa watoto wenye seli mundu katika hospitali ya Muhimbili na Temeke.

Lengo la utafiti : Kuangalia kiwango, sababu na athari za utapiamlo kwa seli mundu katika hospitali ya Muhimbili na Temeke.

Usiri : Majina ya washiriki wa utafiti huu hayatahitajika , miaka, jinsia, namba za utambuzi. Habari zote zitakazo kusanywa wakati wa utafiti zitatumika kwa wahusika wa utafiti tunaziharibu baada ya ripoti ya utafiti kuwa imekubalika kwa ajili kutunuki washahada ya uzamili.

Washiriki wa utafiti

Watoto woe wenye selimundu wenye umri kati ya miezi sita hadi miaka 15. Watapimwa urefu na uzito . Na pia watapimwa wingi wa damu kama kawaida yao na kipimo kingine cha kuangalia wingi wa vitamin B12.

Madhara

Hakuna madhara yanayo tarajiwa kwa washiriki wa utafiti.

Faida

Matokeo ya utafiti huu ya tasaidia kuboresha huduma za afya ya lishe kwa watoto wenye selimundu.

Haki ya kujitoa

Ushiriki katika utafitini wa hiyari, mshiriki yoyote anahaki ya kuamua kujitoa katika utafiti wakati wowote kujitoa hakutaathiri kiwango cha huduma kwa mgonjwa.

Mawasiliano : **Dr. Evelyne Banda**

Mtafiti

Chuo kikuu cha afya na tiba Muhimbili

Idara ya magonjwa ya damu
S.L.P 65001 Dar es Salaam

Simu. 0768 327 758

AU

Dr Lulu Chirande

Msimamizi wa utafiti

Chuo kikuu cha afya na tiba Muhimbili

Idara ya magonjwa ya damu

S.L.P.65001 Dar es Salaam.

Simu. 0684209112

AU

Prof Julie Makani

Msimamizi wa utafiti

Chuo kikuu cha afya na tiba Muhimbili

Idara ya magonjwa ya damu
S.L.P 65001 Dar es Salaam.
Simu. 0754381551
AU

Dr Helena Tom
Msimamizi wa tafiti
Hospitali ya Taifa Muhimbili
Idara ya magonjwa ya damu
S.L.P 65000 Dar es Salaam
Simu.0713721288

Mimi ……nimesoma na kuelewa maelezo yaliyo kwenye fomu hii na maswali yangu ya mejibiwa na ninakubal ikushiriki kwenye utafiti huu.

Sahihi ya mshiriki……..

Sahihi ya mtafiti/mtafiti msaidizi…….

Appendix IV. Questionnaire: Swahili Version

SEHEMU A: TAARIFA YA MGONJWA

NAMBA YA DODOSO ……. NAMBA YA JALADA ……..

1. Umri ……tarehe ya kuzaliwa……..
2. Jinsia
   a) Kiume b) kike
3. Mahali anapoishi
   a) Ilala
   b) Kinondoni
   c) Temeke
   d) kwengine
4. Hali ya Bima ya afya
   a) NHIF
   b) AAR
   c) Hana
   d) Mengineyo taja
5. Idadi ya wanafamilia
   a) 1-4
   b) ≥ 5
6. Idadi ya watoto katika familia
   a) 1 b) 2 c) 3 d) > 3
7. Idadi ya watoto katika familia chini ya umri wa miaka 5
   a) 1
   b) 2
   c) 3
   d) Hakuna
8. Kipato cha mama/mlezi
   a) Anakipato b) Hana
9. Kipato cha baba/mlezi
   a) Anakipato b)Hana

SEHEMU B: ATHOPOMETRIC MEASUREMENTS

10. Mzunguko wa katikati wa mkono…….
11. Uzito…….kg
12. Urefu/mlalo……cm.
13. Uzito/urefu…….kg/cm
14. Urefu/Umri…….kg/months
15. BMI
16. Hali ya lishe
    a) udumavu
    b) kukonda
    c) kawaida
    d) mnene
    e) udumavu na kukonda

SEHEMU C: SABABU ZA UTAPIA MLO

17. Kiwango cha elimu ya mama/mlezi

    a) Hana elimu

    b)Darasa la 7

    c) Kidato cha 4

    d) Kidato cha 6

    e) Chuo kikuu

20. Lishe ndani ya masaa 24

    a) Protini, vitamini, wanga, madini

    b) wanga, Vitamini

    c) wanga, protini

21. Idadi ya milo kwa siku

    a) 2

    b) 3

    c) 4

SEHEMU D: ATHARI

20.Kiasi cha damu…….

21.Kiasi cha Vitamini B12 …..

a) Kawaida(187-883pg/ml)

b) Chini ya kiwango

SEHEMU E: MATUMIZI YA HYDROXYUREA

22. Anatumia HU

a) Ndiyo

b) Hapana

23.Kwa muda gani?

a) <6months

b) 6 months to one year

c) >one year

APPENDIX V. WHO SCORE CHART FOR MALNUTRITION

Weight-for-age from birth to 5 years: Boys

Months	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
0	2.1	2.5	2.9	3.3	3.9	4.4	5.0
1	2.9	3.4	3.9	4.5	5.1	5.8	6.6
2	3.8	4.3	4.9	5.6	6.3	7.1	8.0
3	4.4	5.0	5.7	6.4	7.2	8.0	9.0
4	4.9	5.6	6.2	7.0	7.8	8.7	9.7
5	5.3	6.0	6.7	7.5	8.4	9.3	10.4
6	5.7	6.4	7.1	7.9	8.8	9.8	10.9
7	5.9	6.7	7.4	8.3	9.2	10.3	11.4
8	6.2	6.9	7.7	8.6	9.6	10.7	11.9
9	6.4	7.1	8.0	8.9	9.9	11.0	12.3
10	6.6	7.4	8.2	9.2	10.2	11.4	12.7
11	6.8	7.6	8.4	9.4	10.5	11.7	13.0
12	6.9	7.7	8.6	9.6	10.8	12.0	13.3
13	7.1	7.9	8.8	9.9	11.0	12.3	13.7
14	7.2	8.1	9.0	10.1	11.3	12.6	14.0
15	7.4	8.3	9.2	10.3	11.5	12.8	14.3
16	7.5	8.4	9.4	10.5	11.7	13.1	14.6
17	7.7	8.6	9.6	10.7	12.0	13.4	14.9
18	7.8	8.8	9.8	10.9	12.2	13.7	15.3
19	8.0	8.9	10.0	11.1	12.5	13.9	15.6
20	8.1	9.1	10.1	11.3	12.7	14.2	15.9
21	8.2	9.2	10.3	11.5	12.9	14.5	16.2
22	8.4	9.4	10.5	11.8	13.2	14.7	16.5
23	8.5	9.5	10.7	12.0	13.4	15.0	16.8
24	8.6	9.7	10.8	12.2	13.6	15.3	17.1
25	8.8	9.8	11.0	12.4	13.9	15.5	17.5
26	8.9	10.0	11.2	12.5	14.1	15.8	17.8
27	9.0	10.1	11.3	12.7	14.3	16.1	18.1
28	9.1	10.2	11.5	12.9	14.5	16.3	18.4
29	9.2	10.4	11.7	13.1	14.8	16.6	18.7
30	9.4	10.5	11.8	13.3	15.0	16.9	19.0
31	9.5	10.7	12.0	13.5	15.2	17.1	19.3
32	9.6	10.8	12.1	13.7	15.4	17.4	19.6
33	9.7	10.9	12.3	13.8	15.6	17.6	19.9
34	9.8	11.0	12.4	14.0	15.8	17.8	20.2
35	9.9	11.2	12.6	14.2	16.0	18.1	20.4
36	10.0	11.3	12.7	14.3	16.2	18.3	20.7
37	10.1	11.4	12.9	14.5	16.4	18.6	21.0
38	10.2	11.5	13.0	14.7	16.6	18.8	21.3
39	10.3	11.6	13.1	14.8	16.8	19.0	21.6

Months	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
40	10.4	11.8	13.3	15.0	17.0	19.3	21.9
41	10.5	11.9	13.4	15.2	17.2	19.5	22.1
42	10.6	12.0	13.6	15.3	17.4	19.7	22.4
43	10.7	12.1	13.7	15.5	17.6	20.0	22.7
44	10.8	12.2	13.8	15.7	17.8	20.2	23.0
45	10.9	12.4	14.0	15.8	18.0	20.5	23.3
46	11.0	12.5	14.1	16.0	18.2	20.7	23.6
47	11.1	12.6	14.3	16.2	18.4	20.9	23.9
48	11.2	12.7	14.4	16.3	18.6	21.2	24.2
49	11.3	12.8	14.5	16.5	18.8	21.4	24.5
50	11.4	12.9	14.7	16.7	19.0	21.7	24.8
51	11.5	13.1	14.8	16.8	19.2	21.9	25.1
52	11.6	13.2	15.0	17.0	19.4	22.2	25.4
53	11.7	13.3	15.1	17.2	19.6	22.4	25.7
54	11.8	13.4	15.2	17.3	19.8	22.7	26.0
55	11.9	13.5	15.4	17.5	20.0	22.9	26.3
56	12.0	13.6	15.5	17.7	20.2	23.2	26.6
57	12.1	13.7	15.6	17.8	20.4	23.4	26.9
58	12.2	13.8	15.8	18.0	20.6	23.7	27.2
59	12.3	14.0	15.9	18.2	20.8	23.9	27.6
60	12.4	14.1	16.0	18.3	21.0	24.2	27.9

Weight-for-age from birth to 5 years: Girls

Months	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
0	2.0	2.4	2.8	3.2	3.7	4.2	4.8
1	2.7	3.2	3.6	4.2	4.8	5.5	6.2
2	3.4	3.9	4.5	5.1	5.8	6.6	7.5
3	4.0	4.5	5.2	5.8	6.6	7.5	8.5
4	4.4	5.0	5.7	6.4	7.3	8.2	9.3
5	4.8	5.4	6.1	6.9	7.8	8.8	10.0
6	5.1	5.7	6.5	7.3	8.2	9.3	10.6

Months	−3 SD	−2 SD	−1 SD	Median	1 SD	2 SD	3 SD
7	5.3	6.0	6.8	7.6	8.6	9.8	11.1
8	5.6	6.3	7.0	7.9	9.0	10.2	11.6
9	5.8	6.5	7.3	8.2	9.3	10.5	12.0
10	5.9	6.7	7.5	8.5	9.6	10.9	12.4
11	6.1	6.9	7.7	8.7	9.9	11.2	12.8
12	6.3	7.0	7.9	8.9	10.1	11.5	13.1
13	6.4	7.2	8.1	9.2	10.4	11.8	13.5
14	6.6	7.4	8.3	9.4	10.6	12.1	13.8
15	6.7	7.6	8.5	9.6	10.9	12.4	14.1
16	6.9	7.7	8.7	9.8	11.1	12.6	14.5
17	7.0	7.9	8.9	10.0	11.4	12.9	14.8
18	7.2	8.1	9.1	10.2	11.6	13.2	15.1
19	7.3	8.2	9.2	10.4	11.8	13.5	15.4
20	7.5	8.4	9.4	10.6	12.1	13.7	15.7
21	7.6	8.6	9.6	10.9	12.3	14.0	16.0
22	7.8	8.7	9.8	11.1	12.5	14.3	16.4
23	7.9	8.9	10.0	11.3	12.8	14.6	16.7
24	8.1	9.0	10.2	11.5	13.0	14.8	17.0
25	8.2	9.2	10.3	11.7	13.3	15.1	17.3
26	8.4	9.4	10.5	11.9	13.5	15.4	17.7
27	8.5	9.5	10.7	12.1	13.7	15.7	18.0
28	8.6	9.7	10.9	12.3	14.0	16.0	18.3
29	8.8	9.8	11.1	12.5	14.2	16.2	18.7
30	8.9	10.0	11.2	12.7	14.4	16.5	19.0
31	9.0	10.1	11.4	12.9	14.7	16.8	19.3
32	9.1	10.3	11.6	13.1	14.9	17.1	19.6
33	9.3	10.4	11.7	13.3	15.1	17.3	20.0
34	9.4	10.5	11.9	13.5	15.4	17.6	20.3
35	9.5	10.7	12.0	13.7	15.6	17.9	20.6
36	9.6	10.8	12.2	13.9	15.8	18.1	20.9
37	9.7	10.9	12.4	14.0	16.0	18.4	21.3

Months	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
38	9.8	11.1	12.5	14.2	16.3	18.7	21.6
39	9.9	11.2	12.7	14.4	16.5	19.0	22.0
40	10.1	11.3	12.8	14.6	16.7	19.2	22.3
41	10.2	11.5	13.0	14.8	16.9	19.5	22.7
42	10.3	11.6	13.1	15.0	17.2	19.8	23.0
43	10.4	11.7	13.3	15.2	17.4	20.1	23.4
44	10.5	11.8	13.4	15.3	17.6	20.4	23.7
45	10.6	12.0	13.6	15.5	17.8	20.7	24.1
46	10.7	12.1	13.7	15.7	18.1	20.9	24.5
47	10.8	12.2	13.9	15.9	18.3	21.2	24.8
48	10.9	12.3	14.0	16.1	18.5	21.5	25.2
49	11.0	12.4	14.2	16.3	18.8	21.8	25.5
50	11.1	12.6	14.3	16.4	19.0	22.1	25.9
51	11.2	12.7	14.5	16.6	19.2	22.4	26.3
52	11.3	12.8	14.6	16.8	19.4	22.6	26.6
53	11.4	12.9	14.8	17.0	19.7	22.9	27.0
54	11.5	13.0	14.9	17.2	19.9	23.2	27.4
55	11.6	13.2	15.1	17.3	20.1	23.5	27.7
56	11.7	13.3	15.2	17.5	20.3	23.8	28.1
57	11.8	13.4	15.3	17.7	20.6	24.1	28.5
58	11.9	13.5	15.5	17.9	20.8	24.4	28.8
59	12.0	13.6	15.6	18.0	21.0	24.6	29.2
60	12.1	13.7	15.8	18.2	21.2	24.9	29.5

Weight for length from birth to 2 years for Boys

Length (cm)	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
45.0	1.9	2.0	2.2	2.4	2.7	3.0	3.3
45.5	1.9	2.1	2.3	2.5	2.8	3.1	3.4
46.0	2.0	2.2	2.4	2.6	2.9	3.1	3.5
46.5	2.1	2.3	2.5	2.7	3.0	3.2	3.6
47.0	2.1	2.3	2.5	2.8	3.0	3.3	3.7
47.5	2.2	2.4	2.6	2.9	3.1	3.4	3.8
48.0	2.3	2.5	2.7	2.9	3.2	3.6	3.9
48.5	2.3	2.6	2.8	3.0	3.3	3.7	4.0

Length (cm)	−3 SD	−2 SD	−1 SD	Median	1 SD	2 SD	3 SD
49.0	2.4	2.6	2.9	3.1	3.4	3.8	4.2
49.5	2.5	2.7	3.0	3.2	3.5	3.9	4.3
50.0	2.6	2.8	3.0	3.3	3.6	4.0	4.4
50.5	2.7	2.9	3.1	3.4	3.8	4.1	4.5
51.0	2.7	3.0	3.2	3.5	3.9	4.2	4.7
51.5	2.8	3.1	3.3	3.6	4.0	4.4	4.8
52.0	2.9	3.2	3.5	3.8	4.1	4.5	5.0
52.5	3.0	3.3	3.6	3.9	4.2	4.6	5.1
53.0	3.1	3.4	3.7	4.0	4.4	4.8	5.3
53.5	3.2	3.5	3.8	4.1	4.5	4.9	5.4
54.0	3.3	3.6	3.9	4.3	4.7	5.1	5.6
54.5	3.4	3.7	4.0	4.4	4.8	5.3	5.8
55.0	3.6	3.8	4.2	4.5	5.0	5.4	6.0
55.5	3.7	4.0	4.3	4.7	5.1	5.6	6.1
56.0	3.8	4.1	4.4	4.8	5.3	5.8	6.3
56.5	3.9	4.2	4.6	5.0	5.4	5.9	6.5
57.0	4.0	4.3	4.7	5.1	5.6	6.1	6.7
57.5	4.1	4.5	4.9	5.3	5.7	6.3	6.9
58.0	4.3	4.6	5.0	5.4	5.9	6.4	7.1
58.5	4.4	4.7	5.1	5.6	6.1	6.6	7.2
59.0	4.5	4.8	5.3	5.7	6.2	6.8	7.4
59.5	4.6	5.0	5.4	5.9	6.4	7.0	7.6
60.0	4.7	5.1	5.5	6.0	6.5	7.1	7.8
60.5	4.8	5.2	5.6	6.1	6.7	7.3	8.0
61.0	4.9	5.3	5.8	6.3	6.8	7.4	8.1
61.5	5.0	5.4	5.9	6.4	7.0	7.6	8.3
62.0	5.1	5.6	6.0	6.5	7.1	7.7	8.5
62.5	5.2	5.7	6.1	6.7	7.2	7.9	8.6
63.0	5.3	5.8	6.2	6.8	7.4	8.0	8.8
63.5	5.4	5.9	6.4	6.9	7.5	8.2	8.9
64.0	5.5	6.0	6.5	7.0	7.6	8.3	9.1

Length (cm)	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
64.5	5.6	6.1	6.6	7.1	7.8	8.5	9.3
65.0	5.7	6.2	6.7	7.3	7.9	8.6	9.4
65.5	5.8	6.3	6.8	7.4	8.0	8.7	9.6
66.0	5.9	6.4	6.9	7.5	8.2	8.9	9.7
66.5	6.0	6.5	7.0	7.6	8.3	9.0	9.9
67.0	6.1	6.6	7.1	7.7	8.4	9.2	10.0
67.5	6.2	6.7	7.2	7.9	8.5	9.3	10.2
68.0	6.3	6.8	7.3	8.0	8.7	9.4	10.3
68.5	6.4	6.9	7.5	8.1	8.8	9.6	10.5
69.0	6.5	7.0	7.6	8.2	8.9	9.7	10.6
69.5	6.6	7.1	7.7	8.3	9.0	9.8	10.8
70.0	6.6	7.2	7.8	8.4	9.2	10.0	10.9
70.5	6.7	7.3	7.9	8.5	9.3	10.1	11.1
71.0	6.8	7.4	8.0	8.6	9.4	10.2	11.2
71.5	6.9	7.5	8.1	8.8	9.5	10.4	11.3
72.0	7.0	7.6	8.2	8.9	9.6	10.5	11.5
72.5	7.1	7.6	8.3	9.0	9.8	10.6	11.6
73.0	7.2	7.7	8.4	9.1	9.9	10.8	11.8
73.5	7.2	7.8	8.5	9.2	10.0	10.9	11.9
74.0	7.3	7.9	8.6	9.3	10.1	11.0	12.1
74.5	7.4	8.0	8.7	9.4	10.2	11.2	12.2
75.0	7.5	8.1	8.8	9.5	10.3	11.3	12.3
75.5	7.6	8.2	8.8	9.6	10.4	11.4	12.5
76.0	7.6	8.3	8.9	9.7	10.6	11.5	12.6
76.5	7.7	8.3	9.0	9.8	10.7	11.6	12.7
77.0	7.8	8.4	9.1	9.9	10.8	11.7	12.8
77.5	7.9	8.5	9.2	10.0	10.9	11.9	13.0
78.0	7.9	8.6	9.3	10.1	11.0	12.0	13.1
78.5	8.0	8.7	9.4	10.2	11.1	12.1	13.2
79.0	8.1	8.7	9.5	10.3	11.2	12.2	13.3
79.5	8.2	8.8	9.5	10.4	11.3	12.3	13.4

WEIGHT-FOR-LENGTH FROM BIRTH TO 2 YEARS: BOYS

Length (cm)	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
80.0	8.2	8.9	9.6	10.4	11.4	12.4	13.6
80.5	8.3	9.0	9.7	10.5	11.5	12.5	13.7
81.0	8.4	9.1	9.8	10.6	11.6	12.6	13.8
81.5	8.5	9.1	9.9	10.7	11.7	12.7	13.9
82.0	8.5	9.2	10.0	10.8	11.8	12.8	14.0
82.5	8.6	9.3	10.1	10.9	11.9	13.0	14.2
83.0	8.7	9.4	10.2	11.0	12.0	13.1	14.3
83.5	8.8	9.5	10.3	11.2	12.1	13.2	14.4
84.0	8.9	9.6	10.4	11.3	12.2	13.3	14.6
84.5	9.0	9.7	10.5	11.4	12.4	13.5	14.7
85.0	9.1	9.8	10.6	11.5	12.5	13.6	14.9
85.5	9.2	9.9	10.7	11.6	12.6	13.7	15.0
86.0	9.3	10.0	10.8	11.7	12.8	13.9	15.2
86.5	9.4	10.1	11.0	11.9	12.9	14.0	15.3
87.0	9.5	10.2	11.1	12.0	13.0	14.2	15.5
87.5	9.6	10.4	11.2	12.1	13.2	14.3	15.6
88.0	9.7	10.5	11.3	12.2	13.3	14.5	15.8
88.5	9.8	10.6	11.4	12.4	13.4	14.6	15.9
89.0	9.9	10.7	11.5	12.5	13.5	14.7	16.1
89.5	10.0	10.8	11.6	12.6	13.7	14.9	16.2
90.0	10.1	10.9	11.8	12.7	13.8	15.0	16.4
90.5	10.2	11.0	11.9	12.8	13.9	15.1	16.5
91.0	10.3	11.1	12.0	13.0	14.1	15.3	16.7
91.5	10.4	11.2	12.1	13.1	14.2	15.4	16.8
92.0	10.5	11.3	12.2	13.2	14.3	15.6	17.0
92.5	10.6	11.4	12.3	13.3	14.4	15.7	17.1
93.0	10.7	11.5	12.4	13.4	14.6	15.8	17.3
93.5	10.7	11.6	12.5	13.5	14.7	16.0	17.4
94.0	10.8	11.7	12.6	13.7	14.8	16.1	17.6
94.5	10.9	11.8	12.7	13.8	14.9	16.3	17.7
95.0	11.0	11.9	12.8	13.9	15.1	16.4	17.9

WEIGHT-FOR-LENGTH FROM BIRTH TO 2 YEARS: BOYS

Length (cm)	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
95.5	11.1	12.0	12.9	14.0	15.2	16.5	18.0
96.0	11.2	12.1	13.1	14.1	15.3	16.7	18.2
96.5	11.3	12.2	13.2	14.3	15.5	16.8	18.4
97.0	11.4	12.3	13.3	14.4	15.6	17.0	18.5
97.5	11.5	12.4	13.4	14.5	15.7	17.1	18.7
98.0	11.6	12.5	13.5	14.6	15.9	17.3	18.9
98.5	11.7	12.6	13.6	14.8	16.0	17.5	19.1
99.0	11.8	12.7	13.7	14.9	16.2	17.6	19.2
99.5	11.9	12.8	13.9	15.0	16.3	17.8	19.4
100.0	12.0	12.9	14.0	15.2	16.5	18.0	19.6
100.5	12.1	13.0	14.1	15.3	16.6	18.1	19.8
101.0	12.2	13.2	14.2	15.4	16.8	18.3	20.0
101.5	12.3	13.3	14.4	15.6	16.9	18.5	20.2
102.0	12.4	13.4	14.5	15.7	17.1	18.7	20.4
102.5	12.5	13.5	14.6	15.9	17.3	18.8	20.6
103.0	12.6	13.6	14.8	16.0	17.4	19.0	20.8
103.5	12.7	13.7	14.9	16.2	17.6	19.2	21.0
104.0	12.8	13.9	15.0	16.3	17.8	19.4	21.2
104.5	12.9	14.0	15.2	16.5	17.9	19.6	21.5
105.0	13.0	14.1	15.3	16.6	18.1	19.8	21.7
105.5	13.2	14.2	15.4	16.8	18.3	20.0	21.9
106.0	13.3	14.4	15.6	16.9	18.5	20.2	22.1
106.5	13.4	14.5	15.7	17.1	18.6	20.4	22.4
107.0	13.5	14.6	15.9	17.3	18.8	20.6	22.6
107.5	13.6	14.7	16.0	17.4	19.0	20.8	22.8
108.0	13.7	14.9	16.2	17.6	19.2	21.0	23.1
108.5	13.8	15.0	16.3	17.8	19.4	21.2	23.3
109.0	14.0	15.1	16.5	17.9	19.6	21.4	23.6
109.5	14.1	15.3	16.6	18.1	19.8	21.7	23.8
110.0	14.2	15.4	16.8	18.3	20.0	21.9	24.1

Weight for length from birth to 2 years for girls

Length (cm)	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
45.0	1.9	2.1	2.3	2.5	2.7	3.0	3.3
45.5	2.0	2.1	2.3	2.5	2.8	3.1	3.4
46.0	2.0	2.2	2.4	2.6	2.9	3.2	3.5
46.5	2.1	2.3	2.5	2.7	3.0	3.3	3.6
47.0	2.2	2.4	2.6	2.8	3.1	3.4	3.7
47.5	2.2	2.4	2.6	2.9	3.2	3.5	3.8
48.0	2.3	2.5	2.7	3.0	3.3	3.6	4.0
48.5	2.4	2.6	2.8	3.1	3.4	3.7	4.1
49.0	2.4	2.6	2.9	3.2	3.5	3.8	4.2
49.5	2.5	2.7	3.0	3.3	3.6	3.9	4.3
50.0	2.6	2.8	3.1	3.4	3.7	4.0	4.5
50.5	2.7	2.9	3.2	3.5	3.8	4.2	4.6
51.0	2.8	3.0	3.3	3.6	3.9	4.3	4.8
51.5	2.8	3.1	3.4	3.7	4.0	4.4	4.9
52.0	2.9	3.2	3.5	3.8	4.2	4.6	5.1
52.5	3.0	3.3	3.6	3.9	4.3	4.7	5.2
53.0	3.1	3.4	3.7	4.0	4.4	4.9	5.4
53.5	3.2	3.5	3.8	4.2	4.6	5.0	5.5
54.0	3.3	3.6	3.9	4.3	4.7	5.2	5.7
54.5	3.4	3.7	4.0	4.4	4.8	5.3	5.9
55.0	3.5	3.8	4.2	4.5	5.0	5.5	6.1
55.5	3.6	3.9	4.3	4.7	5.1	5.7	6.3
56.0	3.7	4.0	4.4	4.8	5.3	5.8	6.4
56.5	3.8	4.1	4.5	5.0	5.4	6.0	6.6
57.0	3.9	4.3	4.6	5.1	5.6	6.1	6.8
57.5	4.0	4.4	4.8	5.2	5.7	6.3	7.0
58.0	4.1	4.5	4.9	5.4	5.9	6.5	7.1
58.5	4.2	4.6	5.0	5.5	6.0	6.6	7.3
59.0	4.3	4.7	5.1	5.6	6.2	6.8	7.5
59.5	4.4	4.8	5.3	5.7	6.3	6.9	7.7

Length (cm)	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
60.0	4.5	4.9	5.4	5.9	6.4	7.1	7.8
60.5	4.6	5.0	5.5	6.0	6.6	7.3	8.0
61.0	4.7	5.1	5.6	6.1	6.7	7.4	8.2
61.5	4.8	5.2	5.7	6.3	6.9	7.6	8.4
62.0	4.9	5.3	5.8	6.4	7.0	7.7	8.5
62.5	5.0	5.4	5.9	6.5	7.1	7.8	8.7
63.0	5.1	5.5	6.0	6.6	7.3	8.0	8.8
63.5	5.2	5.6	6.2	6.7	7.4	8.1	9.0
64.0	5.3	5.7	6.3	6.9	7.5	8.3	9.1
64.5	5.4	5.8	6.4	7.0	7.6	8.4	9.3
65.0	5.5	5.9	6.5	7.1	7.8	8.6	9.5
65.5	5.5	6.0	6.6	7.2	7.9	8.7	9.6
66.0	5.6	6.1	6.7	7.3	8.0	8.8	9.8
66.5	5.7	6.2	6.8	7.4	8.1	9.0	9.9
67.0	5.8	6.3	6.9	7.5	8.3	9.1	10.0
67.5	5.9	6.4	7.0	7.6	8.4	9.2	10.2
68.0	6.0	6.5	7.1	7.7	8.5	9.4	10.3
68.5	6.1	6.6	7.2	7.9	8.6	9.5	10.5
69.0	6.1	6.7	7.3	8.0	8.7	9.6	10.6
69.5	6.2	6.8	7.4	8.1	8.8	9.7	10.7
70.0	6.3	6.9	7.5	8.2	9.0	9.9	10.9
70.5	6.4	6.9	7.6	8.3	9.1	10.0	11.0
71.0	6.5	7.0	7.7	8.4	9.2	10.1	11.1
71.5	6.5	7.1	7.7	8.5	9.3	10.2	11.3
72.0	6.6	7.2	7.8	8.6	9.4	10.3	11.4
72.5	6.7	7.3	7.9	8.7	9.5	10.5	11.5
73.0	6.8	7.4	8.0	8.8	9.6	10.6	11.7
73.5	6.9	7.4	8.1	8.9	9.7	10.7	11.8
74.0	6.9	7.5	8.2	9.0	9.8	10.8	11.9
74.5	7.0	7.6	8.3	9.1	9.9	10.9	12.0
75.0	7.1	7.7	8.4	9.1	10.0	11.0	12.2

Length (cm)	−3 SD	−2 SD	−1 SD	Median	1 SD	2 SD	3 SD
75.5	7.1	7.8	8.5	9.2	10.1	11.1	12.3
76.0	7.2	7.8	8.5	9.3	10.2	11.2	12.4
76.5	7.3	7.9	8.6	9.4	10.3	11.4	12.5
77.0	7.4	8.0	8.7	9.5	10.4	11.5	12.6
77.5	7.4	8.1	8.8	9.6	10.5	11.6	12.8
78.0	7.5	8.2	8.9	9.7	10.6	11.7	12.9
78.5	7.6	8.2	9.0	9.8	10.7	11.8	13.0
79.0	7.7	8.3	9.1	9.9	10.8	11.9	13.1
79.5	7.7	8.4	9.1	10.0	10.9	12.0	13.3
80.0	7.8	8.5	9.2	10.1	11.0	12.1	13.4
80.5	7.9	8.6	9.3	10.2	11.2	12.3	13.5
81.0	8.0	8.7	9.4	10.3	11.3	12.4	13.7
81.5	8.1	8.8	9.5	10.4	11.4	12.5	13.8
82.0	8.1	8.8	9.6	10.5	11.5	12.6	13.9
82.5	8.2	8.9	9.7	10.6	11.6	12.8	14.1
83.0	8.3	9.0	9.8	10.7	11.8	12.9	14.2
83.5	8.4	9.1	9.9	10.9	11.9	13.1	14.4
84.0	8.5	9.2	10.1	11.0	12.0	13.2	14.5
84.5	8.6	9.3	10.2	11.1	12.1	13.3	14.7
85.0	8.7	9.4	10.3	11.2	12.3	13.5	14.9
85.5	8.8	9.5	10.4	11.3	12.4	13.6	15.0
86.0	8.9	9.7	10.5	11.5	12.6	13.8	15.2
86.5	9.0	9.8	10.6	11.6	12.7	13.9	15.4
87.0	9.1	9.9	10.7	11.7	12.8	14.1	15.5
87.5	9.2	10.0	10.9	11.8	13.0	14.2	15.7
88.0	9.3	10.1	11.0	12.0	13.1	14.4	15.9
88.5	9.4	10.2	11.1	12.1	13.2	14.5	16.0
89.0	9.5	10.3	11.2	12.2	13.4	14.7	16.2
89.5	9.6	10.4	11.3	12.3	13.5	14.8	16.4
90.0	9.7	10.5	11.4	12.5	13.7	15.0	16.5
90.5	9.8	10.6	11.5	12.6	13.8	15.1	16.7

WEIGHT-FOR-LENGTH FROM BIRTH TO 2 YEARS: GIRLS

Length (cm)	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
91.0	9.9	10.7	11.7	12.7	13.9	15.3	16.9
91.5	10.0	10.8	11.8	12.8	14.1	15.5	17.0
92.0	10.1	10.9	11.9	13.0	14.2	15.6	17.2
92.5	10.1	11.0	12.0	13.1	14.3	15.8	17.4
93.0	10.2	11.1	12.1	13.2	14.5	15.9	17.5
93.5	10.3	11.2	12.2	13.3	14.6	16.1	17.7
94.0	10.4	11.3	12.3	13.5	14.7	16.2	17.9
94.5	10.5	11.4	12.4	13.6	14.9	16.4	18.0
95.0	10.6	11.5	12.6	13.7	15.0	16.5	18.2
95.5	10.7	11.6	12.7	13.8	15.2	16.7	18.4
96.0	10.8	11.7	12.8	14.0	15.3	16.8	18.6
96.5	10.9	11.8	12.9	14.1	15.4	17.0	18.7
97.0	11.0	12.0	13.0	14.2	15.6	17.1	18.9
97.5	11.1	12.1	13.1	14.4	15.7	17.3	19.1
98.0	11.2	12.2	13.3	14.5	15.9	17.5	19.3
98.5	11.3	12.3	13.4	14.6	16.0	17.6	19.5
99.0	11.4	12.4	13.5	14.8	16.2	17.8	19.6
99.5	11.5	12.5	13.6	14.9	16.3	18.0	19.8
100.0	11.6	12.6	13.7	15.0	16.5	18.1	20.0
100.5	11.7	12.7	13.9	15.2	16.6	18.3	20.2
101.0	11.8	12.8	14.0	15.3	16.8	18.5	20.4
101.5	11.9	13.0	14.1	15.5	17.0	18.7	20.6
102.0	12.0	13.1	14.3	15.6	17.1	18.9	20.8
102.5	12.1	13.2	14.4	15.8	17.3	19.0	21.0
103.0	12.3	13.3	14.5	15.9	17.5	19.2	21.3
103.5	12.4	13.5	14.7	16.1	17.6	19.4	21.5
104.0	12.5	13.6	14.8	16.2	17.8	19.6	21.7
104.5	12.6	13.7	15.0	16.4	18.0	19.8	21.9
105.0	12.7	13.8	15.1	16.5	18.2	20.0	22.2
105.5	12.8	14.0	15.3	16.7	18.4	20.2	22.4
106.0	13.0	14.1	15.4	16.9	18.5	20.5	22.6

Length (cm)	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
106.5	13.1	14.3	15.6	17.1	18.7	20.7	22.9
107.0	13.2	14.4	15.7	17.2	18.9	20.9	23.1
107.5	13.3	14.5	15.9	17.4	19.1	21.1	23.4
108.0	13.5	14.7	16.0	17.6	19.3	21.3	23.6
108.5	13.6	14.8	16.2	17.8	19.5	21.6	23.9
109.0	13.7	15.0	16.4	18.0	19.7	21.8	24.2
109.5	13.9	15.1	16.5	18.1	20.0	22.0	24.4
110.0	14.0	15.3	16.7	18.3	20.2	22.3	24.7

Table A5.2.3 Weight-for-height from 2 to 5 years: Boys

Height (cm)	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
65.0	5.9	6.3	6.9	7.4	8.1	8.8	9.6
65.5	6.0	6.4	7.0	7.6	8.2	8.9	9.8
66.0	6.1	6.5	7.1	7.7	8.3	9.1	9.9
66.5	6.1	6.6	7.2	7.8	8.5	9.2	10.1
67.0	6.2	6.7	7.3	7.9	8.6	9.4	10.2
67.5	6.3	6.8	7.4	8.0	8.7	9.5	10.4
68.0	6.4	6.9	7.5	8.1	8.8	9.6	10.5
68.5	6.5	7.0	7.6	8.2	9.0	9.8	10.7
69.0	6.6	7.1	7.7	8.4	9.1	9.9	10.8
69.5	6.7	7.2	7.8	8.5	9.2	10.0	11.0
70.0	6.8	7.3	7.9	8.6	9.3	10.2	11.1
70.5	6.9	7.4	8.0	8.7	9.5	10.3	11.3
71.0	6.9	7.5	8.1	8.8	9.6	10.4	11.4
71.5	7.0	7.6	8.2	8.9	9.7	10.6	11.6
72.0	7.1	7.7	8.3	9.0	9.8	10.7	11.7
72.5	7.2	7.8	8.4	9.1	9.9	10.8	11.8
73.0	7.3	7.9	8.5	9.2	10.0	11.0	12.0
73.5	7.4	7.9	8.6	9.3	10.2	11.1	12.1
74.0	7.4	8.0	8.7	9.4	10.3	11.2	12.2
74.5	7.5	8.1	8.8	9.5	10.4	11.3	12.4

WEIGHT-FOR-HEIGHT FROM 2 TO 5 YEARS: BOYS

Height (cm)	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
75.0	7.6	8.2	8.9	9.6	10.5	11.4	12.5
75.5	7.7	8.3	9.0	9.7	10.6	11.6	12.6
76.0	7.7	8.4	9.1	9.8	10.7	11.7	12.8
76.5	7.8	8.5	9.2	9.9	10.8	11.8	12.9
77.0	7.9	8.5	9.2	10.0	10.9	11.9	13.0
77.5	8.0	8.6	9.3	10.1	11.0	12.0	13.1
78.0	8.0	8.7	9.4	10.2	11.1	12.1	13.3
78.5	8.1	8.8	9.5	10.3	11.2	12.2	13.4
79.0	8.2	8.8	9.6	10.4	11.3	12.3	13.5
79.5	8.3	8.9	9.7	10.5	11.4	12.4	13.6
80.0	8.3	9.0	9.7	10.6	11.5	12.6	13.7
80.5	8.4	9.1	9.8	10.7	11.6	12.7	13.8
81.0	8.5	9.2	9.9	10.8	11.7	12.8	14.0
81.5	8.6	9.3	10.0	10.9	11.8	12.9	14.1
82.0	8.7	9.3	10.1	11.0	11.9	13.0	14.2
82.5	8.7	9.4	10.2	11.1	12.1	13.1	14.4
83.0	8.8	9.5	10.3	11.2	12.2	13.3	14.5
83.5	8.9	9.6	10.4	11.3	12.3	13.4	14.6
84.0	9.0	9.7	10.5	11.4	12.4	13.5	14.8
84.5	9.1	9.9	10.7	11.5	12.5	13.7	14.9
85.0	9.2	10.0	10.8	11.7	12.7	13.8	15.1
85.5	9.3	10.1	10.9	11.8	12.8	13.9	15.2
86.0	9.4	10.2	11.0	11.9	12.9	14.1	15.4
86.5	9.5	10.3	11.1	12.0	13.1	14.2	15.5
87.0	9.6	10.4	11.2	12.2	13.2	14.4	15.7
87.5	9.7	10.5	11.3	12.3	13.3	14.5	15.8
88.0	9.8	10.6	11.5	12.4	13.5	14.7	16.0
88.5	9.9	10.7	11.6	12.5	13.6	14.8	16.1
89.0	10.0	10.8	11.7	12.6	13.7	14.9	16.3
89.5	10.1	10.9	11.8	12.8	13.9	15.1	16.4
90.0	10.2	11.0	11.9	12.9	14.0	15.2	16.6

WEIGHT-FOR-HEIGHT FROM 2 TO 5 YEARS: BOYS

Height (cm)	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
90.5	10.3	11.1	12.0	13.0	14.1	15.3	16.7
91.0	10.4	11.2	12.1	13.1	14.2	15.5	16.9
91.5	10.5	11.3	12.2	13.2	14.4	15.6	17.0
92.0	10.6	11.4	12.3	13.4	14.5	15.8	17.2
92.5	10.7	11.5	12.4	13.5	14.6	15.9	17.3
93.0	10.8	11.6	12.6	13.6	14.7	16.0	17.5
93.5	10.9	11.7	12.7	13.7	14.9	16.2	17.6
94.0	11.0	11.8	12.8	13.8	15.0	16.3	17.8
94.5	11.1	11.9	12.9	13.9	15.1	16.5	17.9
95.0	11.1	12.0	13.0	14.1	15.3	16.6	18.1
95.5	11.2	12.1	13.1	14.2	15.4	16.7	18.3
96.0	11.3	12.2	13.2	14.3	15.5	16.9	18.4
96.5	11.4	12.3	13.3	14.4	15.7	17.0	18.6
97.0	11.5	12.4	13.4	14.6	15.8	17.2	18.8
97.5	11.6	12.5	13.6	14.7	15.9	17.4	18.9
98.0	11.7	12.6	13.7	14.8	16.1	17.5	19.1
98.5	11.8	12.8	13.8	14.9	16.2	17.7	19.3
99.0	11.9	12.9	13.9	15.1	16.4	17.9	19.5
99.5	12.0	13.0	14.0	15.2	16.5	18.0	19.7
100.0	12.1	13.1	14.2	15.4	16.7	18.2	19.9
100.5	12.2	13.2	14.3	15.5	16.9	18.4	20.1
101.0	12.3	13.3	14.4	15.6	17.0	18.5	20.3
101.5	12.4	13.4	14.5	15.8	17.2	18.7	20.5
102.0	12.5	13.6	14.7	15.9	17.3	18.9	20.7
102.5	12.6	13.7	14.8	16.1	17.5	19.1	20.9
103.0	12.8	13.8	14.9	16.2	17.7	19.3	21.1
103.5	12.9	13.9	15.1	16.4	17.8	19.5	21.3
104.0	13.0	14.0	15.2	16.5	18.0	19.7	21.6
104.5	13.1	14.2	15.4	16.7	18.2	19.9	21.8
105.0	13.2	14.3	15.5	16.8	18.4	20.1	22.0
105.5	13.3	14.4	15.6	17.0	18.5	20.3	22.2

WEIGHT-FOR-HEIGHT FROM 2 TO 5 YEARS: BOYS

Height (cm)	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
106.0	13.4	14.5	15.8	17.2	18.7	20.5	22.5
106.5	13.5	14.7	15.9	17.3	18.9	20.7	22.7
107.0	13.7	14.8	16.1	17.5	19.1	20.9	22.9
107.5	13.8	14.9	16.2	17.7	19.3	21.1	23.2
108.0	13.9	15.1	16.4	17.8	19.5	21.3	23.4
108.5	14.0	15.2	16.5	18.0	19.7	21.5	23.7
109.0	14.1	15.3	16.7	18.2	19.8	21.8	23.9
109.5	14.3	15.5	16.8	18.3	20.0	22.0	24.2
110.0	14.4	15.6	17.0	18.5	20.2	22.2	24.4
110.5	14.5	15.8	17.1	18.7	20.4	22.4	24.7
111.0	14.6	15.9	17.3	18.9	20.7	22.7	25.0
111.5	14.8	16.0	17.5	19.1	20.9	22.9	25.2
112.0	14.9	16.2	17.6	19.2	21.1	23.1	25.5
112.5	15.0	16.3	17.8	19.4	21.3	23.4	25.8
113.0	15.2	16.5	18.0	19.6	21.5	23.6	26.0
113.5	15.3	16.6	18.1	19.8	21.7	23.9	26.3
114.0	15.4	16.8	18.3	20.0	21.9	24.1	26.6
114.5	15.6	16.9	18.5	20.2	22.1	24.4	26.9
115.0	15.7	17.1	18.6	20.4	22.4	24.6	27.2
115.5	15.8	17.2	18.8	20.6	22.6	24.9	27.5
116.0	16.0	17.4	19.0	20.8	22.8	25.1	27.8
116.5	16.1	17.5	19.2	21.0	23.0	25.4	28.0
117.0	16.2	17.7	19.3	21.2	23.3	25.6	28.3
117.5	16.4	17.9	19.5	21.4	23.5	25.9	28.6
118.0	16.5	18.0	19.7	21.6	23.7	26.1	28.9
118.5	16.7	18.2	19.9	21.8	23.9	26.4	29.2
119.0	16.8	18.3	20.0	22.0	24.1	26.6	29.5
119.5	16.9	18.5	20.2	22.2	24.4	26.9	29.8
120.0	17.1	18.6	20.4	22.4	24.6	27.2	30.1

Table A5.2.4 Weight-for-height from 2 to 5 years: Girls

Height (cm)	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
65.0	5.6	6.1	6.6	7.2	7.9	8.7	9.7
65.5	5.7	6.2	6.7	7.4	8.1	8.9	9.8
66.0	5.8	6.3	6.8	7.5	8.2	9.0	10.0
66.5	5.8	6.4	6.9	7.6	8.3	9.1	10.1
67.0	5.9	6.4	7.0	7.7	8.4	9.3	10.2
67.5	6.0	6.5	7.1	7.8	8.5	9.4	10.4
68.0	6.1	6.6	7.2	7.9	8.7	9.5	10.5
68.5	6.2	6.7	7.3	8.0	8.8	9.7	10.7
69.0	6.3	6.8	7.4	8.1	8.9	9.8	10.8
69.5	6.3	6.9	7.5	8.2	9.0	9.9	10.9
70.0	6.4	7.0	7.6	8.3	9.1	10.0	11.1
70.5	6.5	7.1	7.7	8.4	9.2	10.1	11.2
71.0	6.6	7.1	7.8	8.5	9.3	10.3	11.3
71.5	6.7	7.2	7.9	8.6	9.4	10.4	11.5
72.0	6.7	7.3	8.0	8.7	9.5	10.5	11.6
72.5	6.8	7.4	8.1	8.8	9.7	10.6	11.7
73.0	6.9	7.5	8.1	8.9	9.8	10.7	11.8
73.5	7.0	7.6	8.2	9.0	9.9	10.8	12.0
74.0	7.0	7.6	8.3	9.1	10.0	11.0	12.1
74.5	7.1	7.7	8.4	9.2	10.1	11.1	12.2
75.0	7.2	7.8	8.5	9.3	10.2	11.2	12.3
75.5	7.2	7.9	8.6	9.4	10.3	11.3	12.5
76.0	7.3	8.0	8.7	9.5	10.4	11.4	12.6
76.5	7.4	8.0	8.7	9.6	10.5	11.5	12.7
77.0	7.5	8.1	8.8	9.6	10.6	11.6	12.8
77.5	7.5	8.2	8.9	9.7	10.7	11.7	12.9
78.0	7.6	8.3	9.0	9.8	10.8	11.8	13.1
78.5	7.7	8.4	9.1	9.9	10.9	12.0	13.2
79.0	7.8	8.4	9.2	10.0	11.0	12.1	13.3
79.5	7.8	8.5	9.3	10.1	11.1	12.2	13.4

WEIGHT-FOR-HEIGHT FROM 2 TO 5 YEARS: GIRLS

Height (cm)	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
80.0	7.9	8.6	9.4	10.2	11.2	12.3	13.6
80.5	8.0	8.7	9.5	10.3	11.3	12.4	13.7
81.0	8.1	8.8	9.6	10.4	11.4	12.6	13.9
81.5	8.2	8.9	9.7	10.6	11.6	12.7	14.0
82.0	8.3	9.0	9.8	10.7	11.7	12.8	14.1
82.5	8.4	9.1	9.9	10.8	11.8	13.0	14.3
83.0	8.5	9.2	10.0	10.9	11.9	13.1	14.5
83.5	8.5	9.3	10.1	11.0	12.1	13.3	14.6
84.0	8.6	9.4	10.2	11.1	12.2	13.4	14.8
84.5	8.7	9.5	10.3	11.3	12.3	13.5	14.9
85.0	8.8	9.6	10.4	11.4	12.5	13.7	15.1
85.5	8.9	9.7	10.6	11.5	12.6	13.8	15.3
86.0	9.0	9.8	10.7	11.6	12.7	14.0	15.4
86.5	9.1	9.9	10.8	11.8	12.9	14.2	15.6
87.0	9.2	10.0	10.9	11.9	13.0	14.3	15.8
87.5	9.3	10.1	11.0	12.0	13.2	14.5	15.9
88.0	9.4	10.2	11.1	12.1	13.3	14.6	16.1
88.5	9.5	10.3	11.2	12.3	13.4	14.8	16.3
89.0	9.6	10.4	11.4	12.4	13.6	14.9	16.4
89.5	9.7	10.5	11.5	12.5	13.7	15.1	16.6
90.0	9.8	10.6	11.6	12.6	13.8	15.2	16.8
90.5	9.9	10.7	11.7	12.8	14.0	15.4	16.9
91.0	10.0	10.9	11.8	12.9	14.1	15.5	17.1
91.5	10.1	11.0	11.9	13.0	14.3	15.7	17.3
92.0	10.2	11.1	12.0	13.1	14.4	15.8	17.4
92.5	10.3	11.2	12.1	13.3	14.5	16.0	17.6
93.0	10.4	11.3	12.3	13.4	14.7	16.1	17.8
93.5	10.5	11.4	12.4	13.5	14.8	16.3	17.9
94.0	10.6	11.5	12.5	13.6	14.9	16.4	18.1
94.5	10.7	11.6	12.6	13.8	15.1	16.6	18.3
95.0	10.8	11.7	12.7	13.9	15.2	16.7	18.5

Height (cm)	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
95.5	10.8	11.8	12.8	14.0	15.4	16.9	18.6
96.0	10.9	11.9	12.9	14.1	15.5	17.0	18.8
96.5	11.0	12.0	13.1	14.3	15.6	17.2	19.0
97.0	11.1	12.1	13.2	14.4	15.8	17.4	19.2
97.5	11.2	12.2	13.3	14.5	15.9	17.5	19.3
98.0	11.3	12.3	13.4	14.7	16.1	17.7	19.5
98.5	11.4	12.4	13.5	14.8	16.2	17.9	19.7
99.0	11.5	12.5	13.7	14.9	16.4	18.0	19.9
99.5	11.6	12.7	13.8	15.1	16.5	18.2	20.1
100.0	11.7	12.8	13.9	15.2	16.7	18.4	20.3
100.5	11.9	12.9	14.1	15.4	16.9	18.6	20.5
101.0	12.0	13.0	14.2	15.5	17.0	18.7	20.7
101.5	12.1	13.1	14.3	15.7	17.2	18.9	20.9
102.0	12.2	13.3	14.5	15.8	17.4	19.1	21.1
102.5	12.3	13.4	14.6	16.0	17.5	19.3	21.4
103.0	12.4	13.5	14.7	16.1	17.7	19.5	21.6
103.5	12.5	13.6	14.9	16.3	17.9	19.7	21.8
104.0	12.6	13.8	15.0	16.4	18.1	19.9	22.0
104.5	12.8	13.9	15.2	16.6	18.2	20.1	22.3
105.0	12.9	14.0	15.3	16.8	18.4	20.3	22.5
105.5	13.0	14.2	15.5	16.9	18.6	20.5	22.7
106.0	13.1	14.3	15.6	17.1	18.8	20.8	23.0
106.5	13.3	14.5	15.8	17.3	19.0	21.0	23.2
107.0	13.4	14.6	15.9	17.5	19.2	21.2	23.5
107.5	13.5	14.7	16.1	17.7	19.4	21.4	23.7
108.0	13.7	14.9	16.3	17.8	19.6	21.7	24.0
108.5	13.8	15.0	16.4	18.0	19.8	21.9	24.3
109.0	13.9	15.2	16.6	18.2	20.0	22.1	24.5
109.5	14.1	15.4	16.8	18.4	20.3	22.4	24.8
110.0	14.2	15.5	17.0	18.6	20.5	22.6	25.1
110.5	14.4	15.7	17.1	18.8	20.7	22.9	25.4

WEIGHT-FOR-HEIGHT FROM 2 TO 5 YEARS: GIRLS

Height (cm)	–3 SD	–2 SD	–1 SD	Median	1 SD	2 SD	3 SD
111.0	14.5	15.8	17.3	19.0	20.9	23.1	25.7
111.5	14.7	16.0	17.5	19.2	21.2	23.4	26.0
112.0	14.8	16.2	17.7	19.4	21.4	23.6	26.2
112.5	15.0	16.3	17.9	19.6	21.6	23.9	26.5
113.0	15.1	16.5	18.0	19.8	21.8	24.2	26.8
113.5	15.3	16.7	18.2	20.0	22.1	24.4	27.1
114.0	15.4	16.8	18.4	20.2	22.3	24.7	27.4
114.5	15.6	17.0	18.6	20.5	22.6	25.0	27.8
115.0	15.7	17.2	18.8	20.7	22.8	25.2	28.1
115.5	15.9	17.3	19.0	20.9	23.0	25.5	28.4
116.0	16.0	17.5	19.2	21.1	23.3	25.8	28.7
116.5	16.2	17.7	19.4	21.3	23.5	26.1	29.0
117.0	16.3	17.8	19.6	21.5	23.8	26.3	29.3
117.5	16.5	18.0	19.8	21.7	24.0	26.6	29.6
118.0	16.6	18.2	19.9	22.0	24.2	26.9	29.9
118.5	16.8	18.4	20.1	22.2	24.5	27.2	30.3
119.0	16.9	18.5	20.3	22.4	24.7	27.4	30.6
119.5	17.1	18.7	20.5	22.6	25.0	27.7	30.9
120.0	17.3	18.9	20.7	22.8	25.2	28.0	31.2

APPENDIX VI. Approval Ethical clearance

UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

OFFICE OF THE DIRECTOR - RESEARCH AND PUBLICATIONS

In reply quote;

Ref. No.DA.282/298/01.C/

Date: 22/12/2020

MUHAS-REC-12-2020-446

Evelyne Modestus Banda,
MMed -Haematology and Blood Transfusion,
School of Medicine
MUHAS

RE: APPROVAL FOR ETHICAL CLEARANCE FOR A STUDY TITLED: TITLE: PREVALENCE AND FACTORS ASSOCIATED WITH MALNUTRITION IN PATIENTS WITH SICKLE CELL DISEASE

Reference is made to the above heading.

I am pleased to inform you that the Chairman has on behalf of the University Senate, approved ethical clearance of the above-mentioned study, on recommendations of the Senate Research and Publications Committee meeting accordance with MUHAS research policy and Tanzania regulations governing human and animal subjects research.

APPROVAL DATE: 22/12/2020
EXPIRATION DATE OF APPROVAL: 21/12/2021

STUDY DESCRIPTION:
Purpose:
the purpose of this cross sectional study is to determine the prevalence, factors and complications associated with malnutrition in patients with SCD at MNH and Temeke Hospitals

The approved protocol and procedures for this study is attached and stamped with this letter, and can be found in the link provided: https://irb.muhas.ac.tz/storage/Certificates/Certificate%20-%20267.pdf and in the MUHAS archives.

The PI is required to:

1. Submit bi-annual progress reports and final report upon completion of the study.
2. Report to the IRB any unanticipated problem involving risks to subjects or others including adverse events where applicable.
3. Apply for renewal of approval of ethical clearance one (1) month prior its expiration if the study is not completed at the end of this ethical approval. You may not continue with any research activity beyond the expiration date without the approval of the IRB. Failure to receive approval for continuation before the expiration date will result in automatic termination of the approval for this study on the expiration date.
4. Obtain IRB amendment (s) approval for any changes to any aspect of this study before they can be implemented.
5. Data security is ultimately the responsibility of the investigator.
6. Apply for and obtain data transfer agreement (DTA) from NIMR if data will be transferred to a foreign country.
7. Apply for and obtain data transfer agreement (DTA) from NIMR if data will be transferred to a foreign country.
8. Apply for and obtain material transfer agreement (MTA) from NIMR, if research materials (samples) will be shipped to a foreign country,
9. Any researcher, who contravenes or fail to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine as per NIMR Act No. 23 of 1979, PART III section 10 (2)
10. The PI is required to ensure that the findings of the study are disseminated to relevant stake holders.
11. PI is required to be versed with necessary laws and regulatory policies that govern research in Tanzania. Some guidance is available on our website https://drp.muhas.ac.tz/.

Dr. Emmanuel Balandya
Ag. Chairman, MUHAS Research and Ethics Committee

Cc: Director of Postgraduate Studies, MUHAS

9 United Nations Road; Upanga West; P.O. Box 65001, Dar Es Salaam: Tel. G/Line: +255-22-2150302/6; Ext. 1038; Direct Line:+255-22-2152489;Telefax:+255-22-2152489;E-mail:drp@muhas.ac.tz;Web:https://www.muhas.ac.tz

APPENDIX VII. Introduction letter to Hospital Temeke Referral

UNITED REPUBLIC OF TANZANIA
MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES
OFFICE OF THE DIRECTOR – POSTGRADUATE STUDIES

In reply quote;

Ref. No. Ref. No. HD/MUH/T.58/2018 — 29th December, 2020

The Medical Officer In-Charge,
Temeke Referral Regional Hospital,
P.O. Box 32823,
DAR ES SALAAM

Re: INTRODUCTION LETTER

The bearer of this letter is Evelyne Modestus Banda, a student at Muhimbili University of Health and Allied Sciences (MUHAS) pursuing MMed. Haematology and Blood Transfution.

As part of her studies she intends to do a study titled: "**Prevalence and Factors Associated with Malnutrition in Patients with Sickle Cell Disease.**"

The research has been approved by the Chairman of University Senate.

Kindly provide her the necessary assistance to facilitate the conduct of her research.

We thank you for your cooperation.

Ms. Victoria Mwanilwa
For: DIRECTOR, POSTGRADUATE STUDIES

cc: Dean, School of Medicine, **MUHAS**
cc: Evelyne Modestus Banda

9 United Nations Road; Upanga West; P.O. Box 65001, Dar Es Salaam: Tel. G/Line: +255-22-2150302/6; Ext. 1015; Direct Line:+255-22-2151378;Telefax:+255-22-2150465;E-mail:dpgs@muhas.ac.tz;Web:https://www.muhas.ac.tz

APPENDIX VII. Introduction letter to Muhimbili National Hospital

UNITED REPUBLIC OF TANZANIA
MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES
OFFICE OF THE DIRECTOR – POSTGRADUATE STUDIES

In reply quote;

Ref. No. Ref. No. HD/MUH/T.58/2018 29th December, 2020

The Executive Director,
Muhimbili National Hospital,
P.O. Box 65000,
DAR ES SALAAM

Re: INTRODUCTION LETTER

The bearer of this letter is Evelyne Modestus Banda, a student at Muhimbili University of Health and Allied Sciences (MUHAS) pursuing MMed. Haematology and Blood Transfution.

As part of her studies she intends to do a study titled: **"Prevalence and Factors Associated with Malnutrition in Patients with Sickle Cell Disease."**

The research has been approved by the Chairman of University Senate.

Kindly provide her the necessary assistance to facilitate the conduct of her research.

We thank you for your cooperation.

Ms. Victoria Mwanilwa
For: DIRECTOR, POSTGRADUATE STUDIES

cc: Dean, School of Medicine, **MUHAS**
cc: Evelyne Modestus Banda

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