

**FACTORS ASSOCIATED WITH SEVERE ACUTE MALNUTRITION
IN CHILDREN AGED 6-59 MONTHS AT EMBU LEVEL V HOSPITAL**

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DECLARATION

I certify that this dissertation is my original work and has not been presented for the award of a degree in any University.

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DEFINITION OF TERMS

Undernutrition - the outcome of insufficient food intake and repeated infectious diseases. It includes being underweight, stunting and wasting(1).

Underweight - low weight for one's age. It is measured by finding the weight-for-age z-score. A score of -2 standard deviations and below is considered underweight and -3 standard deviations and below is severely underweight(2).

Wasting - low weight for one's height. It reflects an acute malnutrition. It is measured by finding the weight-for-height Z-score. A score of -2 standard deviations and below is considered wasting and -3 standard deviations and below is severe wasting(2).

Stunting - too short for one's age. It reflects a chronic malnutrition. It is measured by finding the height-for-age Z-score. A score of -2 standard deviations and below is considered stunted and -3 standard deviations and below is severely stunted(2).

Severe acute malnutrition - having a WHZ score of below -3SD, or a MUAC of less than 115mm or presence of nutritional oedema(3).

Neonate – a child under 28 days of age.

Infant - a child below one year of age.

Exclusive breastfeeding - giving a baby nothing but breast milk, not even water for the first six months of life(4).

Early initiation of breastfeeding - breastfeeding within one hour of birth(4).

Pre-lacteal feeds - giving a neonate any other feed apart from the mother's milk before initiating breastfeeding(5).

Complementary feeding – introducing feeds other than breast milk to an infant's diet(6).

Oedema - An accumulation of an excessive amount of watery fluid in cells, tissues, or serous cavities(7).

Durable roof – roof made out of corrugated iron sheets, tiles, concrete, asbestos sheets, or tin

Non-durable roof – roof made out of grass, *makuti*, mud, or dung

Durable wall – wall made out of stone, brick or blocks

Non-durable wall – wall made out of mud, wood, corrugated iron sheets, grass, reeds or tin

Durable floor – floor made out of cement, tiles or wood

Non-durable floor – floor made out of earth

Improved water source – piped into dwelling, piped not into dwelling, rain harvested, protected well, protected spring

Unimproved water source – unprotected well, unprotected spring, stream, river, vendor, lake, dam, pond

Improved waste disposal – main sewer, septic tank, cess pool, VIP latrine, covered pit latrine

Unimproved waste disposal – uncovered pit latrine, bucket latrine, bush

LIST OF ABBREVIATIONS

CDC	Centre for Disease Control
HAZ	Height for age Z score
KDHS	Kenya Demographic and Health Survey
MUAC	Mid-upper arm circumference
SD	Standard Deviation
UNICEF	United Nations Children's' Emergency Fund
WAZ	Weight for age Z score
WHO	World Health Organization
WHZ	Weight for height Z score

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ABSTRACT

Background: Childhood malnutrition is a complex problem with far-reaching consequences. The factors that lead to it are varied and inter-connected. The aim of this study is to establish the characteristics of children who develop severe acute malnutrition and are admitted to Embu Level V hospital.

Methodology: A case control study was carried out in Embu Level V hospital paediatric wards. Cases were children with a MUAC of below 11.5 cm or a WHZ score of below -3 SD from the median of WHO reference. Controls were children with a MUAC of above 13.5 cm and a WHZ score of between -1 SD and +1 SD from the median of WHO reference. Anthropometric measurements of child's weight, height and MUAC were taken. Information on demographic, socio-economic, nutritional, child care, household and individual characteristics were collected using an interviewer-administered questionnaire.

Results: A total of 116 children and their caregivers were enrolled in the study, 58 cases and 58 controls. SAM was significantly associated with increasing birth order [AOR (95% CI) 1.90 (1.21, 2.85)], inappropriate initiation of complementary feeding [AOR (95% CI) 2.87 (1.74, 4.71)], increasing feeding frequency [AOR (95% CI) 0.66 (0.53, 0.82)], lacking any form of protein in diet [AOR (95% CI) 2.24 (1.22, 4.11)], monthly family income of below Ksh.10,000 [AOR (95% CI) 1.44 (1.02, 1.40), and owning <1 acre of land [AOR (95% CI) 9.65 (6.09, 15.31)]

In the 6 months prior to this study, 65% had monthly MCH clinic visits, and weight was plotted at each MCH clinic visit more times than height (76.1% and 51.7% respectively). For the cases, a diagnosis of malnutrition was missed 54% of the time.

Conclusion: To reduce SAM in this population, proper infant and young child feeding practises should be encouraged. Increasing access to food and the earning power of families should also be facilitated. Regular and accurate growth monitoring could detect malnutrition early facilitating early intervention.

1 INTRODUCTION

Nearly half of all deaths of children under 5 years (45%) are attributable to undernutrition whether directly or indirectly (8). In 2015 worldwide, 50 million children under 5 years were found to be wasted and 17 million were severely wasted. This represented a 7% and 3% prevalence rate respectively. A quarter of these children live in sub-Saharan Africa (8). In the same period, 23.2% of children were found to be stunted, a third of whom live in sub-Saharan Africa (8).

In Kenya, the prevalence of stunting and severe stunting is 26% and 8% respectively. The prevalence of wasting and severe wasting is 4% and 1% respectively (9). Embu County is located in the former Eastern province and lies 120 kilometres north east of Nairobi. In Embu, the prevalence of stunting and severe stunting is 27% and 7% respectively. The prevalence of wasting and severe wasting is 3% and 0.2% respectively (9).

Table 1.1 Comparison of different forms of malnutrition

	Stunting	Severe stunting	Wasting	Severe wasting	Underweight	Severely underweight
Global	23.2%		7%	3%	13.9%	
Africa	35.6%		8.5%	3.5%	17.7%	
Kenya	26%	8%	4%	1%	11%	2%
Embu	27%	7%	3%	0.2%	11.1%	1.3%

The World Health Organization (WHO) defines malnutrition as the cellular imbalance between the supply of nutrients and energy and the body's demand for them to ensure growth, maintenance, and specific functions (10).

A child's nutritional status is assessed by taking the child's weight, age, height, clinical manifestations and biochemical markers. Indicators based on these measurements are then compared to international standards e.g. WHO, CDC (11).

Malnutrition can be acute (wasting) or chronic (stunting) or a combination of both. Acute malnutrition can be further classified as moderate or severe acute malnutrition depending on the degree of wasting as shown in table 2.

Table 1.2: Classification of Acute malnutrition

	Severe malnutrition	Acute malnutrition	Moderate malnutrition	Acute malnutrition	At risk for malnutrition
WHZ score	$\leq -3SD$		$\leq -2SD$ to $-3SD$		$\leq -1SD$ to $-2SD$
MUAC	< 11.5 cm		11.5 to 12.4cm		12.5 to 13.4cm
Oedema	Present		Absent		Absent

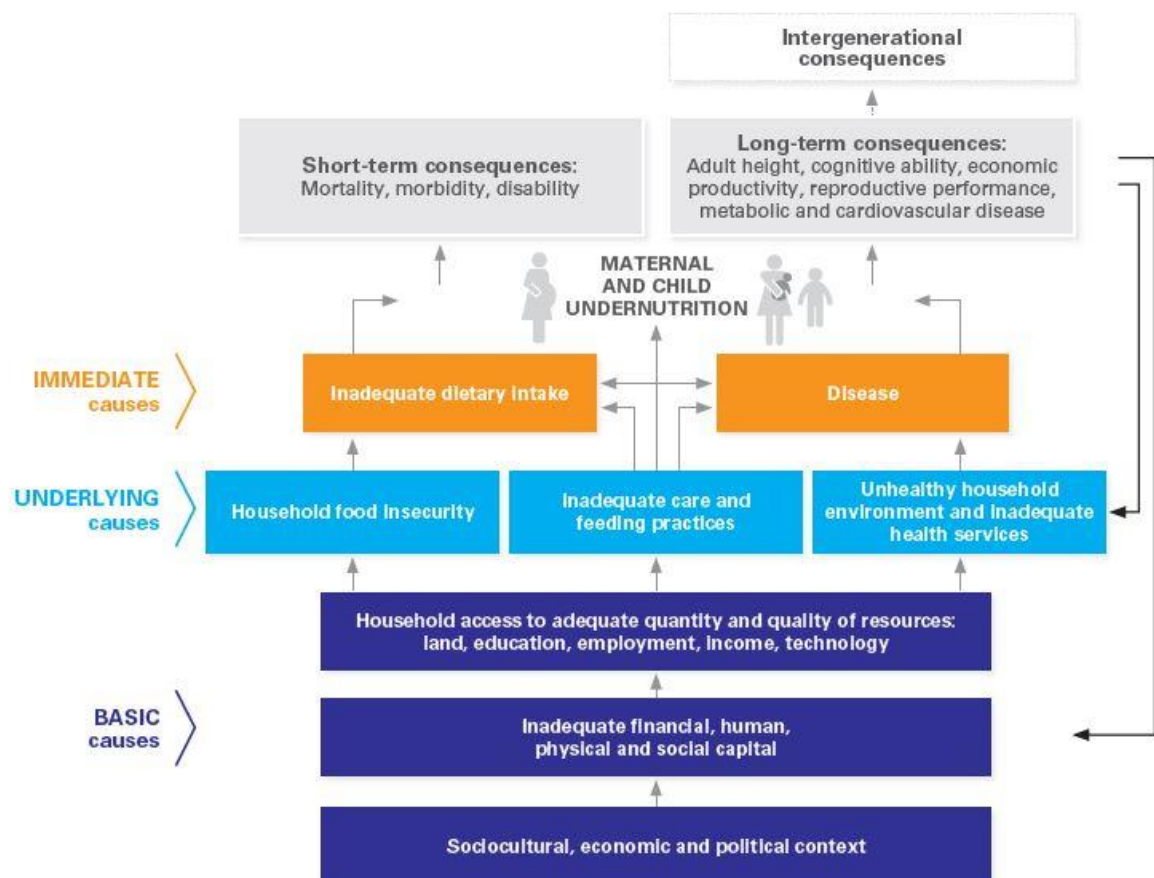
2 LITERATURE REVIEW

2.1 Background

The factors leading to undernutrition are multidimensional, complex and interrelated. The United Nations Children's Emergency Fund (UNICEF) conceptual framework of childhood malnutrition shows causes of malnutrition as being classified into 3 main categories: basic, underlying and immediate causes (figure 1) (11).

The basic causes deal with the society as a whole i.e. its structures and processes. These include social, economic and political factors. The underlying causes deal with factors in the

Figure 2.1: Conceptual framework of determinants of child undernutrition



household and community. The immediate causes are on the level of the individual. Factors at one level contribute to the other levels.

The consequences of malnutrition in children under 5 years are many and affect multiple areas of their lives. They can be irreversible and devastating especially if undernutrition occurs in the first 1,000 days of life, that is, during pregnancy and the first 2 years of life.

During this period, a child has high nutritional demands due to rapid growth, is totally dependent on others to meet his or her nutritional needs and has increased susceptibility to infections (12). This is also the period during which the brain and nervous system development occurs and is completed. Undernutrition during this period affects this development with effect to the brain depending on the type, timing, severity and duration as the brain requires different nutrients at different times for proper development(13).

The consequences of undernutrition can be divided into short-term and long-term consequences(Figure 1). Short-term consequences include reduced immunocompetence, lethargy, delayed milestones and mortality. Long-term consequences include poor school performance, reduced productivity in adulthood, shorter adult height, reduced cognitive ability and metabolic diseases (11).

2.2 Study context

Embu Level V hospital is located on the outskirts of Embu town and serves mainly Embu County and also receives referrals from the surrounding counties. The population of Embu County at the 2009 Kenya Population and Housing Census stood at 516,212 with a projected population in 2017 being 591,415. The under 5 population was at 65,709 in 2009, and is projected to be 73,496 in 2017 (14).

Embu county appears to be divided into two distinct regions. The upper part around Mt. Kenya consists of Runyenjes and Manyatta constituencies and the lower part consists of Mbeere North and Mbeere South constituencies. The upper part is more fertile, more populated and has generally better access to resources than the lower drier region (14).

The malnutrition rates in Embu County compared to the rest of the country are only marginally better (table 1). The second Sustained Development Goal aims to end all forms of malnutrition by the year 2030. To do this, we must identify the factors associated with malnutrition and address them.

2.3 Factors associated with malnutrition in children

According to the UNICEF conceptual framework (figure 1), the factors leading to malnutrition can be discussed under the following titles:

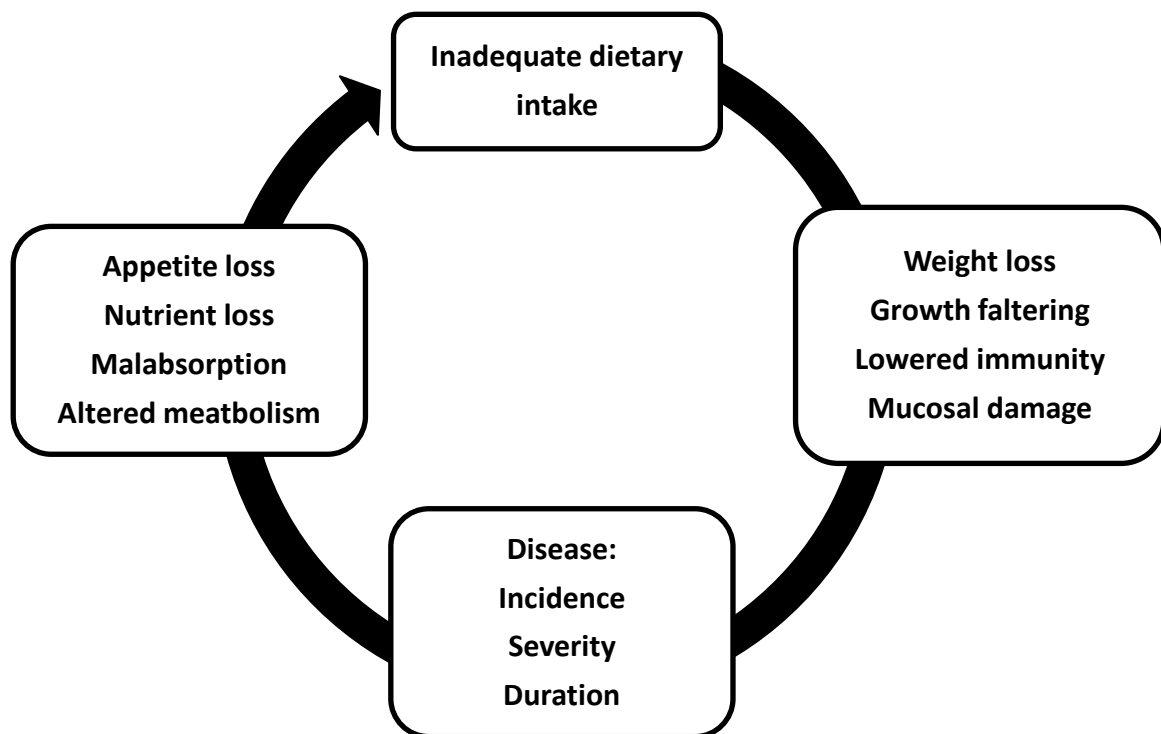
1. Immediate causes:
 - 1.1. Inadequate dietary intake
 - 1.2. Disease

2. Underlying causes:
 - 2.1. Inadequate feeding practises – breastfeeding, complementary feeding
 - 2.2. Inadequate care – health-seeking behaviour, hygiene practises
 - 2.3. Household environment – type of house, access to clean water, sanitation, urban/rural, family size
 - 2.4. Inadequate health services: immunization rates, distance to health facilities
3. Basic causes
 - 3.1. Household access to resources: land ownership and utilization, education, employment, income

2.3.1 Disease and child malnutrition

Of the most common immediate causes of death in children under 5 years of age, malnutrition contributes to a significant extent. The interaction between nutrition and infection is cyclic and closely linked.

Figure 2.2: Malnutrition/Infection Cycle



Several studies have shown an association between a child suffering an illness and the presence of malnutrition(15–17).

2.3.2 Influence of feeding practises and dietary intake on child malnutrition

Correct feeding practices are integral to a child's nutritional status and general well-being. These feeding practices include practising exclusive breastfeeding, early initiation of breastfeeding, avoidance of pre-lacteal feeds, appropriate complementary feeding and practising responsive feeding (6).

Breastmilk is the optimum feed for a child in the first six months of life and provides all the nutrients the baby needs during this time (18). It also provides up to half or more of the nutritional requirements in the second six months and a third in the second year of life (4). When the breastfeeding of infants under 2 years is practised optimally, it has the capacity to prevent over 800,000 deaths (13% of all deaths) in children under 5 in developing countries and consequently is the most potent preventive intervention (19). The advantages of breastfeeding are many (12,20).

Exclusive breastfeeding should be practised for the first six months of life. Along with this breastfeeding should be initiated in the first hour of life, the child should be breastfed on demand, and use of bottles, teats and pacifiers should be discouraged. It is also recommended that a child should be breastfed up to two years (4).

Table 2.1: A comparison of breastfeeding rates (9,25,26)

Indicator	Developing world (21)	Kenya (9)	Former Embu District (22)
Exclusive breastfeeding at 6 months	39 %	61%	34%
Breastfeeding at 2 years	58%	53%	62%

The table above is comparing rates of breastfeeding in Kenya as at 2014 and in the former Embu district as at 2008.

Different studies have shown negative, positive and no correlation between breastfeeding practises and the presence of malnutrition. In developing nations, children not exclusively breastfed for 6 months are more likely to have severe malnutrition (15,17,23,24). There has also been a correlation found between late initiation of breastfeeding and malnutrition (15,17). Ayana et al, found that 51.3% of cases and 35.4% of controls initiated breastfeeding more than one hour after delivery while for Ambadekar et al, it was 21% and 14% respectively. A Malaysian study however found no association between duration of breastfeeding and malnutrition (25).

Pre-lacteal feeds are one of the hindrances to early initiation of breastfeeding and exclusive breastfeeding. Bottle and teat use is discouraged as it carries the risk of infections due to inadequate cleaning. Early use of pacifiers (before 4 weeks) may lead to problems in initiation and maintenance of successful breastfeeding (26).

An association has been found between giving pre-lacteal feeds and malnutrition (17,24) with Ambadekar et al finding 28% of cases and 10% of controls were given pre-lacteal feeds. Bottle feeding has also been associated with the presence of malnutrition (24,27).

Formula is not an adequate substitute for breastmilk as it only replaces the nutritional component of it and not the others e.g. antibodies. Also, in the first few months of life, the baby's gut can only absorb breastmilk well and formula can injure the gut, which can take weeks to recover. In developing countries, formula feeding presents other challenges such as safe and clean preparation and administration and correct dilution (21).

Complementary feeds are introduced when breast milk is no longer adequate to meet the infant's nutritional requirements. The age at which this occurs is between 6-24 months (6).

WHO has set guidelines in regards to complementary feeding (6,28). Complementary feeds should be adequate in amount, frequency, consistency and variety, should be introduced timely, should be safe and appropriate for age. Responsive feeding should be practised.

Children between 6-8 months should be fed 2-3 times a day, increasing to 3-4 times daily between 9-11 months and 12-24 months with additional nutritious snacks offered 1-2 times per day, as desired. Breastfed children require food from three food groups as a minimum while non-breastfed children require food from four food groups including dairy. Non-breastfed children aged 12-23 months should also be fed 4-5 times a day with 1-2 snacks (6,28).

According to KDHS 2014, 91% of children aged 6 -23 months received breast milk or milk products. 41% had been given foods from the appropriate number of food groups and 51% had been fed the minimum number of times appropriate for their age. The feeding practices of only 22% meet the minimum standards with respect to all three of the above practices (9). In the former Embu district, the Multiple Indicator Cluster Survey report classified adequate complementary feeding as breastfeeding and appropriate frequency of feeds according to age. The rate was found to be 80% for children aged 6-11 months (22). The frequency of daily feeds if ≤ 3 times per day increased the risk of SAM by 36% (17). If semi-solids were not

used during the introduction of complementary feeds, the risk of SAM increased by 11% (17).

Children aged 2 to 5 years are usually on the family diet. They have high energy requirements relative to body size as they are still growing and are active. They should have food from the four main food groups given in adequate amounts and frequency. According to the Kenyan Maternal and Child Health booklet, they should receive 3 main meals a day, 2 snacks and 2 cups of milk a day (29).

2.3.3 Level of care and malnutrition

Inadequate care also contributes to the development of malnutrition. Indicators that can be used to reflect this include health-seeking behaviour and hygiene practises.

A delay between a child falling sick and being presented to a health facility was found to be significantly associated with malnutrition with cases taking a mean of 2.1 days to present to hospital and controls taking a mean of 1.9 days (17). Poor hand-washing practices of both mother and child which include not washing hands before meals and after defecation have also been associated with the risk of developing child malnutrition (15,17)

2.3.4 Influence of household environment on childhood malnutrition

The household environment is also a contributor to the development of childhood malnutrition.

Most indicators in Embu county are comparable to the whole country. In Embu County, the houses roofed with durable materials are 15% more than the rest of the country. The urbanization rates in Embu County are approximately half of the rates in the rest of the country.

Table 2.2: Comparison of household environment indicators (33)

Indicators		Kenya	Embu
Housing	Durable roof	81.6%	96.5%
	Non-durable roof	17.7%	3.5%
	Durable floor	43.3%	41.6%
	Non-durable floor	56.5%	58.3%
	Durable wall	33.4%	38.2%
	Non-durable wall	65.7%	59.2%
Water	Improved	56.1%	51.1%
	Unimproved	43.7%	48.8%
Waste disposal	Improved	65%	65.6%
	Unimproved	35%	34.4%
Urbanization rate		31.3%	15.9%
Family size		3.9	3.9
Head of household	Male	67.8%	71.6%
	Female	32.2%	28.4%

Studies have shown a correlation between the type of building materials used for the home and child malnutrition(30,31). Living in a temporary house was associated with severe malnutrition ($p=0.02$)(30) Victora et al, showed that the correlation was less pronounced when income was taken into account(31).

Risk of developing SAM was increased when no method of water purification is used with 15% of cases and 5% of controls not using any method of water purification(17)

There was an association between stunting and underweight and the type of sewage disposal system with the strongest being in those without a toilet(31). Ambadekar et al found an association between SAM and parents not using a latrine with 9% of cases and 22% of controls having a latrine in the household(17). An association was also found between absence of a latrine and malnutrition with 22.1% of cases and 11.9% of controls lacking access to a latrine(15).

Fentaw et al found an association between family size and all forms of undernutrition with households with malnourished children having 1.57, 0.78, and 1.25 more persons than those with normal children in WHZ, WAZ, and HAZ indices, respectively(32) Among the pre-schoolers in Malaysia no association was found between the same(25). Having more than one child per couple was associated with SAM in India(17) but having 4 or more children was not in Malaysia(25). Having a high number of children under 5 years in a household was associated with malnutrition(32).

Living in a rural area increases the risk of developing malnutrition(15). This is probably due to better socioeconomic conditions in urban areas than rural areas leading to better care practices(33). Gewa et al however found higher rates of malnutrition in urban areas(16).

Children living in a female-headed household were more likely to have all three forms of undernutrition(32).

2.3.5 Influence of health services on nutritional status of children

Having inadequate health services contributes to the development of child malnutrition. The indicators that can be used to assess this are distance to a health facility, time taken to reach a health facility and immunization rates among children.

The number of health facilities in Embu County is 157(14). The percentage of fully immunized children is 85.5% compared to a national average of 79%(9).

The lack of age-appropriate vaccination was found to be associated with the risk of having SAM with 26% of cases and 9% of controls lacking age-appropriate vaccinations (17). Ayaya et al also found an association between the completeness of immunization and being malnourished with 36% of cases and 13% of controls not being completely immunized(30). There was an association between the distance to health facility and all forms of malnutrition $p = 0.026$, $p = 0.000$; $p = 0.000$) for wasting, underweight, and stunting respectively.(32).

2.3.6 Individual characteristics and child malnutrition

Some individual characteristics have also been found to be associated with childhood malnutrition.

In Kenya, the prevalence of malnutrition is higher in males than in girls (9,16,30). This may be due to biological factors. It has been argued that natural selection favours the survival of female over male offspring (34). In studies based in Asia however, the opposite has found to be true and this may be due to cultural beliefs and practices (23).

The age at which malnutrition is most likely to occur is 6 to 24 months. This is most likely due to the introduction of inappropriate complementary feeds (28). Low birth weight is a risk factor for undernutrition (16,25,35). Narrow birth interval (<2 years) has also been associated with malnutrition (23,32).

The order of birth has been found to be associated with wasting and being underweight with children of lower order of birth being the ones more affected ($p= 0.00$ and $p=0.01$ respectively) (32). This may be due to the mother shifting attention to the newest child.

Maternal age is one of the factors associated with child malnutrition. Higher maternal age has been found to be protective against undernutrition (13,18,31). Fentaw et al, however, found that having an older caretaker was associated with all forms of childhood undernutrition (32).

Chronic illnesses also contribute to malnutrition although the main form of malnutrition in this group is chronic malnutrition which is not the scope of this study. They may develop acute on chronic malnutrition with acute exacerbation of the illness or a superimposed illness like an infection or any of the other factors mentioned above.

2.3.7 Influence of household access to resources on nutritional status of children

The following table summarizes a comparison between Embu County and the rest of the country in terms of household access to resources.

Table 2.3: Comparison of household access to resources indicators (9,14)

Indicator		Kenya (%)	Embu County (%)
Land	Ownership	66	61.9
	Arable	10.4	59.6
Female level of education	No education	7.0	1.3
	Some primary	25.7	28.6
	Completed primary	24.6	29.2
	Some secondary	15.8	16.6
	Completed secondary	15.7	13.7
	Higher than secondary	11.2	10.6
Male level of education	No education	3.1	1.0
	Some primary	25.1	33.6
	Completed primary	23.0	27.4
	Some secondary	15.8	16.6
	Completed secondary	19.2	12.2
	Higher than secondary	13.8	9.3
Employment rate		69.3	79.8

Most indicators in Embu county are comparable to those of the whole of the country. The biggest difference is found in percentage of arable land with Embu county having 50% more. Embu county also has less percentage of females with no education (6% less), more males with some or completed primary education (13% more) and higher employment rates (10% more).

Embu County is a predominantly agricultural region, with the agricultural sector employing 70.1% of the population and 87.9% of the households are involved in agricultural activities. The agricultural activities include crop farming with food crops (horticultural crops, maize, tea, rice) being farmed more than cash crops (63,760 hectares versus 18,869 hectares). Livestock farming is also practised with the main products being milk, beef, mutton, honey, pork, eggs and fish. Other economic activities include tourism, formal employment, trade, sand harvesting, quarrying and foresting (14).

A case-control study done in Eldoret, Kenya found a significant association between land ownership and severe malnutrition with 45.1% of cases owning land compared to 67.2% of controls (30). A study in Ethiopia in an agro-pastoralist community found that in the WHZ, WAZ, and HAZ indices, there was significant mean difference between the households having normal and malnourished children categories with regard to irrigated farm size ($t = 3.445$, $P = .000$; $t = 2.205$, $P = 0.029$; $t = 2.077$, $P = 0.039$, correspondingly) (32).

Parental education level correlates with nutritional status (25,30,32). The Ethiopian study found that all wasted, 98.8% of underweight and 98.4% of stunted children had illiterate parents(32). The maternal but not paternal educational level was found to be associated with any of the three forms of malnutrition among pre-school children in Malaysia ($p=0.003$) (25). Similar results were found in the Ayaya et al study but the maternal education level ($p=0.000$) was more strongly associated with severe malnutrition than paternal ($p=0.010$) (30).

Family income has been found to have a strong association with nutritional status with the prevalences of stunting, underweight, and wasting being approximately 7, 4, and 2 times higher, respectively, among children from the poorest than among those from the wealthiest homes(31). Both parental incomes have been found to be independently associated with severe malnutrition($p=0.005$ for both)(30). Household income status was also found to be strongly associated with any of the three forms of malnutrition in the Malaysian study ($p<0.001$) (25).

In two studies conducted in Eldoret and Malaysia there was no association found between parental employment and childhood malnutrition (25,30). However a case-control study done in Mbagathi hospital, Kenya found an association between both mothers and fathers employment status and severe acute malnutrition ($p<0001$ and $p=0.001$ respectively) with the children of unemployed parents having higher rates of severe acute malnutrition (36).

Employed mothers [OR 2.4 (95% CI 1.9–3.1)] and unemployed or non-skilled fathers [OR 2.5 (95% CI 1.9–3.2)] was associated with higher risk for childhood SAM (36).

2.4 Interaction with health system

As children are growing, there are usually multiple points of contact with the health systems. In Kenya, mothers are issued with a Mother and Child Health booklet (29) when they first present to a health facility during pregnancy. This booklet is supposed to be used for follow up of the child until five years of age. So ideally, a child should have been seen at a health care facility every month for the first five years of their life.

At each visit, the general well-being is assessed, height and weight are taken, recorded and plotted on the appropriate graphs (weight-for-age and height-for-age), health education is given and the appropriate vaccines are given. If this is done consistently and correctly, then a child who is at risk of developing malnutrition should be picked early and the appropriate intervention instituted. This would prevent a child from developing any form of severe malnutrition.

However, if any of the above actions are not done or done incorrectly, then the opportunity to diagnose malnutrition in its early stages is missed and the child may then present to a health facility already with the severe forms of malnutrition. No studies have currently been done to ascertain how well these steps are followed.

Embu county generally has the same rates of child undernutrition as the rest of the country. This is despite the fact that some of the parameters of factors known to lead to malnutrition are better than in the country as a whole and the others are comparable. Its main economic activity is agriculture, its populace is slightly better educated, it has a higher employment rate than the rest of the country. It is also apparent that the county has two distinct agro-economical areas with wide disparities in the various indicators mentioned above (14).

Embu level V hospital serves Embu county and also receives some referrals from the surrounding counties. The under 5 population in Embu County is 86,242 (14). The average monthly admissions to the hospital of children under 5 years is 150. For the months September and October 2016, out of the children whose nutritional status was assessed (58% of the total admissions), 20% were found to have severe wasting (37). This study endeavours to find out what factors are found more in those with severe acute malnutrition as opposed to

those with normal nutritional status and if there are missed opportunities of catching these children when they are at risk of developing malnutrition and before they develop severe malnutrition.

2.5 Study Justification

SAM is one of the biggest risk factors for child mortality. Severe malnutrition remains an important problem in Embu despite better or comparable factors known to lead to malnutrition with those in the country as a whole and being a predominantly agricultural region. 1 in 5 of children under 5 years of age admitted to Embu Level V hospital have severe acute malnutrition (37). The specific factors leading to SAM in this population are unknown. This study aims to find these factors. Regular attendance of clinic in this population has been found to improve growth parameters (38). Finding out if there are missed opportunities for early diagnosis of SAM is also important. Findings can inform planning, resource allocation and addressing barriers to good nutrition in the county and may result in lower rates of SAM

2.6 Study Question

What are the factors associated with severe malnutrition in children aged 6-59 months admitted to Embu Level V Hospital?

2.7 Study Objectives

Primary objective

To determine the demographic, socio-economic, nutritional, child care, household and individual factors associated with severe malnutrition in children aged 6-59 months admitted to Embu Level V hospital

Secondary objective

To identify missed opportunities in the early diagnosis of severe acute malnutrition during the children's monthly visits to Maternal and Child Health clinics.

3 METHODOLOGY

3.1 Study design

This was a hospital-based case control study

3.2 Study area

The study was carried out in the paediatric wards of Embu Level V Hospital and the MCH clinic.

3.3 Study population

The source population was all children aged 6-59 months admitted to Embu Level V Hospital paediatric ward and attending MCH clinic in the three months the study was carried out. The study participants were identified from this population then enrolled in the study based on the following criteria:

Cases

Inclusion criteria:

- i. Children aged 6 to 59 months
- ii. Children with severe acute malnutrition as defined by having a MUAC of below 11.5 cm or WHZ below -3 SD from the median of WHO reference.

Exclusion criteria:

- i. Children whose caretakers have not been staying with them for six months prior to the study.
- ii. Children unaccompanied by a caretaker
- iii. Children with the following chronic illnesses: cerebral palsy, severe cardiac disease, chronic renal failure

Controls

Inclusion criteria:

- i. Children aged 6 to 59 months

- ii. Age-matched children without severe acute malnutrition as defined by having a MUAC of above 13.5 cm and a WHZ of between -1 SD and +1 SD from the median of WHO reference.

Exclusion criteria:

- i. Children whose caretakers have not been staying with them for six months prior to the study.
- ii. Children unaccompanied by a caretaker.
- iii. Children with the following chronic illnesses: cerebral palsy, severe cardiac disease, chronic renal failure.

3.4 Case definitions

Cases - Children aged 6-59 months admitted to Embu Level V Hospital paediatric wards in whom severe malnutrition is found based on a MUAC of below 11.5 cm or a WHZ of below -3 SD from the median of the WHO reference.

Controls - Children aged 6-59 months admitted to Embu Level V hospital paediatric wards and attending MCH clinic who have good nutritional status based on a MUAC of 13.5 cm and above and a WHZ score of between -1 SD and +1 SD from the median of WHO reference.

3.5 Sample size calculation

The sample size was calculated using Stata version 11.1. The two-sample proportion formula was used with the following assumptions:

- p_1 – the proportion of mothers with 0-8 years of education in Embu (KDHS) = 0.59
- p_2 : proportion of mothers of severely malnourished children with 0-8 years of education in Eldoret (Ayaya, et al) = 0.87
- Power: 90%
- Level of significance: 0.05
- Ratio of samples (Case:Control) 1:1

N = minimum sample size = 58 for each arm

3.6 Sampling methods

Consecutive sampling was done of all the children until the sample size of both arms was reached. The sampling of the cases was done in the paediatric wards, while for the controls took place in both the paediatric wards and the MCH clinic.

3.7 Study variables

Severe acute malnutrition as defined by a MUAC of below 11.5 cm is the dependent variable. The independent variables are child characteristics (age, residence, gender, birth weight, birth order and spacing), parental characteristics (age, occupation and education), household characteristics (family size, head of household, type of house, water source, waste disposal), socio-economic variables (family income, land ownership), child care practices (hand-washing practices, health-seeking behaviour, immunization), and feeding practices (breastfeeding, complementary feeding and dietary intake).

The independent variables for the second objective are monthly visits to the health facility, anthropometry assessment at these visits, diagnosis of malnutrition and interventions instituted.

3.8 Study tools

Data was collected by trained data collectors using an interviewer administered questionnaire.

The data collector was also provided with a MUAC tape and a measuring cup. Weight was taken using an infant weighing scale for those unable to stand without support and a children weighing scale for those who could. Height was taken using a measuring board lying on the floor for those unable to stand without support and standing up for those who could.

Figure 3.1: MUAC tape



Figure 3.2: Measuring board



3.9 Study procedures

The study took place in the Embu Level V paediatric wards on weekdays between 8:00 am and 5:00 pm. The data collectors included the principle investigator and assistants trained on the study tools. The data collectors recruited for the study were qualified clinical officers who are trained non-physician clinicians providing health care. Further training on recruiting, selection of cases and controls, administration of the questionnaire and how to take the measured variables was carried out. This took place at the hospital and took 6 hours. Role play was used to run through how to collect the data. Each data collector was provided with a MUAC tape and a measuring cup.

The data collectors were in the waiting bay of the paediatric ward and MCH clinic. The caregivers of the children were asked if they and their children could be screened for enrolment into the study. This was done by explaining about the study and seeking informed consent. For those who agreed to participate, screening of both the caregiver and the child was done to determine eligibility to be enrolled into the study. The screening parameters included:

- i. The child's age
- ii. How long the caretaker has been taking care of the child
- iii. Mid-upper arm circumference.
- iv. WHZ score

The anthropometric measurements were done in the procedure room of the ward. Those who met the criteria for cases were enrolled into the study and the structured questionnaire for cases was administered. The interviews were conducted in the ward in as much privacy as

possible. All activity pertaining to the study was limited to after the ward round and between nursing procedures.

We then looked for an age-matched control for every case enrolled. The ages of all enrolled cases were entered into a record book daily and were used as a guide to find controls. Control recruitment happened concurrently with the cases recruitment in the ward and the same procedure was followed. All enrolled subjects had an identification number placed on their records to prevent double enrolment.

The measurable variables were done in the following methods:

- **Age** was recorded in number of completed months from available records or reported age from the caretaker in lieu of this.
- **Mid-upper arm circumference** A MUAC tape was provided to all the investigators.

Technique:

1. Locate tip of shoulder and tip of elbow
 2. Place tape at tip of shoulder and pull tape to tip of elbow
 3. Mark the midpoint on the arm
 4. Place the tape at the marked midpoint around the arm and through the gap with the tape not too tight or too loose
 5. Record the length at the arrow of the MUAC tape
 6. Repeat procedure and record the average of the two measurements
- **Weight** measurement was conducted using both infant (for children under 2 years) and child (for children over 2 years) electronic weighing scale. The scales were calibrated daily before use by checking it with a known weight of 10 kilograms. The clothes of the child were removed before the child is weighed. The weight was read to the nearest 0.1 kg and recorded.
 - **Length/Height** measurement depended on whether a child could stand by themselves or not. Length was measured lying down for those who could not stand on their own (<24 months). Height was measured standing up (>24 months). The measurements were taken twice and the average recorded.

Technique for measuring length:

1. Child should be placed in the middle of the board lying flat

2. The child's head should firmly touch the fixed headboard with their line of sight perpendicular to the base of the board
3. The child's legs should be fully extended and the sliding footplate placed firmly on the bottom of their feet perpendicular to the base of the board
4. The height measured is recorded to the nearest 0.5 cm.

Technique for measuring height:

1. Child should stand in the middle of the board body flat against it.
2. The back of the head, shoulders, buttocks, shins and heels should be touching the board
3. Their line of sight should be parallel to the floor
4. Headpiece should be slid down and touch the head firmly and be parallel to the ground
5. The height measured is recorded to the nearest 0.1 cm.

3.10 Data management and analysis

Quantitative data from questionnaires were checked daily for completeness and coded for appropriate computer entry. This Quantitative data was entered into SPSS software version 20 computer programme for data cleaning and analysis. Descriptive statistics were used to analyse variables such as age, sex and socio economic status of the parents. A student's T test was used to establish the association for the numerical data. Bivariate and multivariate analysis were used to establish the association between the different variables such as birth weight, level of education of guardian etc. with malnutrition.

Correlation studies determined associations between birth weight, residence, level of education and occupation of the caretaker and malnutrition among children using Chi square tests were conducted to describe the levels of significance for the association. Inferential analysis was used to determine whether there were any statistically significant differences in the different factors associated with malnutrition between cases and while regression analysis was used to establish the extent to which certain practices such as breastfeeding, type of feeds, amount of feeds etc. influence the nutritional status of the child.

Data collected to assess the gaps in early diagnosis of severe acute malnutrition will be entered into SPSS and the frequency of the different variables e.g. monthly clinic attendance measured and presented in graphs.

3.11 Dissemination plan

The results of the study will be disseminated to the Kenyatta National Hospital Scientific and Ethical Review Committee by submitting a report. A poster presentation will be made to the Department of Paediatrics and Child Health, University of Nairobi. The Department of Paediatrics, Embu Level V hospital will receive a presentation detailing the results of the study. A report of the same will also be submitted to the hospital and the Embu County Health Department.

3.12 Study limitations

This study was a case-control and therefore could not prove causality only associations.

The study partly relied on self-reported data with minimal means of verification and there was risk of recall bias. This was mitigated by shortening the period over which the participants would have to remember events.

3.13 Data was also collected from the maternal and child health booklet. This was sometimes unavailable, inadequately or incorrectly filled. Data protection

All information collected from the study was kept confidential and within the scope of the study. The questionnaire did not contain the respondent's name and was identified with a number instead. Documents containing the respondent's name were not reproduced.

The filled questionnaires were kept under lock and key in a secure box with a slot where the data collectors dropped in the questionnaires. Only the principal investigator had a key to this box and emptied it weekly. The data collected was entered into a password-protected computer that was accessible to only the principal investigator and limited access by the statistician.

3.14 Ethical considerations

Approval to conduct the study was sought from the department of Paediatrics and Child Health, University of Nairobi.

Ethical approval for the study will be sought from the Kenyatta National Hospital Scientific and Ethical Review Committee. Permission to conduct the study was also sought from the Embu Level V Hospital health management team.

Informed consent was sought from the caregivers of all eligible children. The caregivers were informed that withdrawal from the study or a decline to participate would not influence the care of the child.

If a child was found to have severe malnutrition the health care workers in charge of the patients care and the caregivers were informed. Appropriate management for severe malnutrition according to the Basic Paediatric Protocols, 4th edition was instituted for those who had not.

For any child found to have need for emergency care, the health care workers in charge of their care were informed immediately.

4 RESULTS

The study took place at Embu level V hospital paediatric ward and MCH clinic from December 2017 to March 2018. 251 children were screened and a total of 116 children aged between 6 and 59 months, 58 cases and 58 controls, were recruited into the study based on the inclusion and exclusion criteria.

4.1 Characteristics of the study population

Above average of cases (51.7%) were girls and most control respondents (63.8%) were boys. Majority of the respondents (44.8%) were aged between 12 and 23 months. The mean birth weight for controls was 2995 (SD 532) grams while for cases was 2824 (SD 578) grams. 56 of the cases and 55 of the controls had their biological mother as the primary caregiver. 48.3% of the cases were stunted compared to 12.1% of controls. Most of the cases were underweight (93.1%) compared to only 5.2% of controls.

Table 4.1 Characteristics of study population

Characteristics		Control n=58 (%)	Case n=58 (%)
Child sex	Male	37 (63.8)	28 (48.3)
	Female	21 (36.2)	30 (51.7)
Child age (months)	6-8	17 (29.3)	17 (29.3)
	9-11	10 (17.2)	10 (17.2)
	12-23	26 (44.8)	26 (44.8)
	≥ 24	5 (8.6)	5 (8.6)
	Mean (SD)	13.24 (6.1)	13.24 (6.1)
Birth Order	Only child	37 (63.8)	22 (37.9)
	Otherwise	21 (36.2)	36 (62.1)
Birth weight (grams)	Mean (SD)	2995 (532)	2824 (578)
Primary caregiver	Biological mother	55 (94.8)	56 (96.6)
	Others	3 (5.2)	2 (3.4)
Stunted		7 (12.1)	28 (48.3)
Underweight		3 (5.2)	54 (93.1)

Majority of the respondents (41%) were from Manyatta constituency and minority (7%) were from Mbeere North. Manyatta had the highest cases (47%) of severe malnutrition in Embu County; while Mbeere North had the least cases (7%).

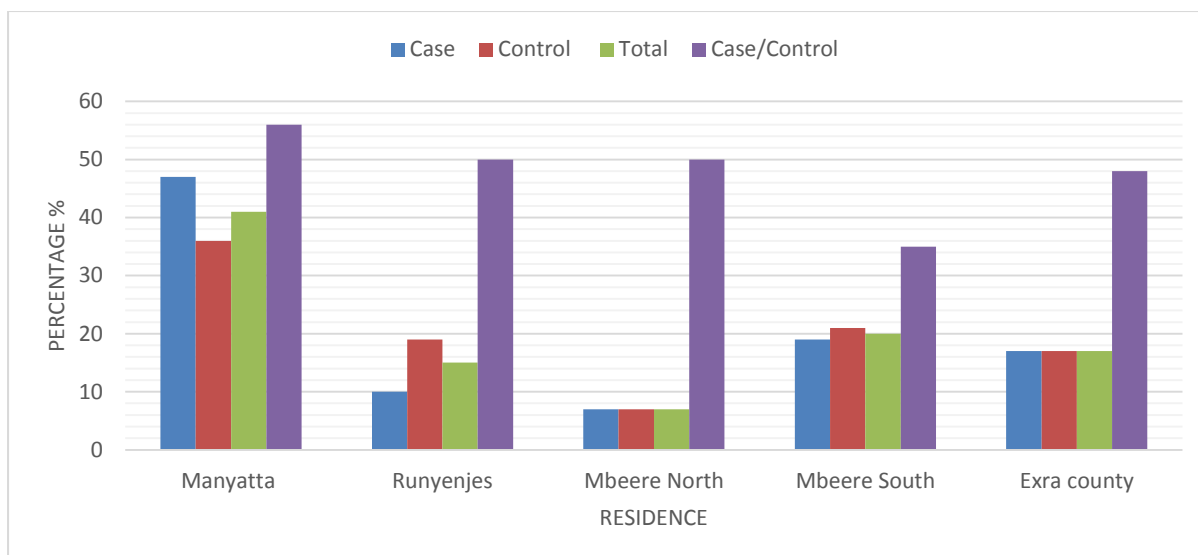


Figure 4.1 Graph showing residence of respondents

4.2 Univariate analysis of characteristics

4.2.1 Effect of demographic and socio-economic factors on SAM

Various factors were examined for association with SAM including: child's gender, residence, owning land, land size owned, practising farming on owned land, the type of farming practised, type of maternal and paternal employment, monthly family income and family access to certain types of technology (radio, mobile phone, television, computer and internet).

The factors found to be significant include: family owning more than 1 acre of land, both parents having reliable employment and a monthly family income of more than Ksh. 10,000.

Controls had a higher proportion of land ownership as compared to cases (65.5% and 48.3%) respectively and showed a trend toward significance ($p=0.062$). Of those who owned land, owning <1 acre of land made a child in that household 4.4 times more likely to develop malnutrition.

Having a reliable source of income was found to be significant for both maternal and paternal employment with having formal employment being classified as the only source of reliable income. Unreliable sources of income were: unemployed, casual labourer and self-employment. Children of mothers with a reliable source of income were 63% less likely to suffer from SAM than those of mothers with an unreliable source of income. Children of

fathers with unreliable source of income were 80% less likely to develop SAM than those of fathers with an unreliable source of income. Earning < Ksh. 10,000 as family income made a child 5.3 times more likely to have SAM.

Table 4.2 Effect of demographic and socioeconomic characteristics on SAM

Characteristics		Control (n=58)	Case (n=58)	OR (95%CI)	p value
Child sex	Male	37 (63.8)	28 (48.3)	0.53 (0.39, 0.72)	0.07
	Female	21 (36.2)	30 (51.7)	Reference category	
Maternal age (years)	Mean (SD)	28.4 (6.3)	29.2 (6.7)	1.02 (.96, 1.08)	0.51
Paternal age (years)	Mean (SD)	32.3 (9.2)	34.0 (6.4)	1.03 (.97, 1.09)	0.33
Land ownership	Yes	38 (65.5)	28 (48.3)	0.49 (0.36, 0.67)	0.06
	No	20(34.9)	30 (51.7)	Reference category	
Land acreage	< 1 Acre	7 (18.4)	14 (50)	4.43 (2.82, 6.95)	0.01*
	≥1 Acre	31 (81.6)	14 (50)	Reference category	
	Missing ¹	20	30		
Farming practice	Yes	32 (84.2)	26 (92.9)	0.42 (0.05, 2.15)	0.29
	No	6 (15.8)	2 (7.1)	Reference category	
	Missing ^o	20	30		
Land utilization	Food crop only	13 (40.6)	14 (53.8)	1.08 (0.53, 2.18)	0.84
	Mixed cropping	15 (46.9)	8 (30.8)	0.53 (0.26, 2.11)	0.09
	Cash crop only	4 (12.5)	4 (15.4)	Reference category	
	Missing ¹	26	32		
Maternal employment	Reliable	21 (36.2)	10 (17.2)	0.37 (0.15, 0.88)	0.02*
	Unreliable	37 (63.8)	48 (82.8)	Reference category	
Paternal Employment	Reliable	23 (52.3)	8 (17.8)	0.20 (0.08, 0.52)	<0.01*
	Unreliable	21 (47.7)	37 (82.2)	Reference category	
	Missing ²	14	13		
Monthly family income	< 10000	5 (9.3)	15 (34.9)	5.25 (3.33, 8.27)	<0.01*
	≥10000	49 (90.7)	28 (65.1)	Reference category	
	Missing ³	4	15		

¹do not own land

*statistically significant

²children without male caregiver

³do not know monthly family income

4.2.2 Effect of nutritional factors on SAM

Factors examined for association with SAM were: initiation of breastfeeding within 1 hour, practising exclusive breastfeeding, formula feeding before 6 months, appropriate initiation of complementary feeding, if a child aged between 6-24 months is still breastfeeding, eating a

well-balanced balanced diet, having a diet lacking dairy protein, animal protein, plant protein, or any protein, feeding frequency and daily amount of feeds given.

Table 4.3: Effect of nutritional factors on SAM

Characteristics		Control n=58 (%)	Case n=58 (%)	OR (95%CI)	<i>p</i>
Length of time before 1st breast feed	1 Hour	33 (60)	29 (50.9)	0.69 (0.51, 0.94)	0.33
	After 1 Hour	22 (40)	28 (49.1)	Reference category	
	Missing ¹	3	1		
Exclusive breast feeding	Achieved	40 (69.0)	37 (63.8)	0.70 (0.31, 1.56)	0.37
	Not Achieved	15 (27.3)	20 (35.1)	Reference category	
	Missing ¹	3	1		
Formula < 6 months	Yes	13 (22.4)	13 (22.4)	1.00 (0.70, 1.43)	1.00
	No	45 (77.6)	45 (77.6)	Reference category	
Complimentary feeding initiation	= 6 months	49 (84.5)	39 (67.2)	0.38 (0.26, 0.54)	0.03*
	> or < 6 months	9 (15.5)	19 (32.8)	Reference category	
Child currently breast feeding between 6-24 months	Yes	42 (82.4)	49 (92.5)	2.63 (1.50, 4.59)	0.10
	No	9 (17.6)	4 (7.5)	Reference category	
	Missing ²	7	5		
Good Diet	Good diet	32 (55.2)	32 (55.2)	1.00 (0.74, 1.35)	1.00
	Poor diet	26 (44.8)	26 (44.8)	Reference category	
Dairy protein in diet	Achieved	48 (82.8)	31 (53.4)	0.24 (0.17, 0.34)	<0.01*
	Not achieved	10 (17.2)	27 (46.6)	Reference category	
Animal protein in diet	Achieved	22 (37.9)	14 (24.1)	0.52 (0.38, 0.72)	0.11
	Not achieved	36 (62.1)	44 (75.9)	Reference category	
Plant protein in diet	Achieved	28 (48.3)	25 (43.1)	0.81 (0.60, 1.09)	0.58
	Not achieved	30 (51.3)	33 (56.9)	Reference category	
Any protein in diet	No	5 (8.6)	15 (25.9)	3.70 (2.27, 6.02)	0.02*
	Yes	53 (91.4)	43 (74.1)	Reference category	
Feeding frequency per day	6-8 Months	5	5	0.60 (0.40, 0.89)	0.01*
	9-11 Months	5.5	5		
	12-23 Months	6	5		
	>= 24 Months	6	5		
	Mean	5.62	5.06		
Daily amount of feeds (Mls)	6-8 Months	825	550	0.999 (0.998, 0.999)	0.03*
	9-11 Months	825	720		
	12-23 Months	975	945		
	>= 24 Months	1080	1350		
	Mean	966.29	815.43		

¹maternal deaths at birth

*statistically significant

² maternal deaths at birth and excluding those above 24 months

The ones found to be significant include: appropriate initiation of complementary feeding lacking dairy protein in diet, lacking any protein in diet, feeding frequency and daily amount of feeds.

Breastfeeding within 1 hour of birth [OR (95% CI) 0.69 (0.51, 0.94); p: 0.33] , exclusive breastfeeding [OR (95% CI) 1.44();p:], formula feeding below 6 months, lacking animal and plant protein in diet were found to have no association with SAM.

Children who had appropriate initiation of complimentary feeding were found to be 62% less likely to have SAM than those initiated either before or after 6 months. Children fed dairy protein were 76% less likely to suffer from SAM than those that were not. Lacking any protein in the diet made a child 3.7 times more likely to suffer from SAM.

On average, across all age groups the frequency of feeding was found to be higher in controls than cases with the total average (5.62 and 5.06 times respectively) and increasing feeding frequency made a child 40% less likely to suffer from SAM. The amount of feeds given per day was also on average higher in controls than cases with the total average (966.29 and 815.43 mls respectively) but its protection against SAM was very low at 1%.

4.2.3 Effect of individual, household, and child care characteristics on SAM

Factors examined for association include: birth order, birth weight, birth spacing, maternal and paternal age, maternal and paternal education, the primary caregiver, the head of household, family size, waste disposal, water source, type of house, maternal hand-washing practise, health-seeking behaviour, and immunization.

The ones found to be significant were: birth order and maternal education. Being an only child was 65% protective against SAM. Being the child of a mother who had less than secondary school education increased the chances of developing SAM by 2.6.

Table 4.4 Individual, household and child care characteristics on SAM

Characteristics		Control n=58 (%)	Case n=58 (%)	OR (95%CI)	p
Birth Order	Only child	37 (63.8)	22 (37.9)	0.35 (0.26, 0.47)	0.01*
	Otherwise	21 (36.2)	36 (62.1)	Reference category	
Birth weight (grams)	Mean (SD)	2995 (532)	2824 (578)	0.999 (0.999, 1.000)	0.11
Birth spacing (months)	Mean (SD)	68.5 (31.8)	72.7 (36.1)	0.996 (0.989, 1.00)	0.34
	Missing	37	22		
Maternal education	Up to primary	11 (19)	22 (37.9)	2.61 (1.85, 3.69)	0.02*
	Higher than primary	47 (81)	36 (62.1)	Reference category	
Paternal education	Up to primary	7 (15.9)	13 (28.9)	2.15 (1.41, 3.27)	0.11
	Higher than primary	37 (84.1)	32 (71.1)	Reference category	
	Missing ¹	14	13		
Head of household	Male	43 (74.1)	43 (74.1)	1.00 (0.71, 1.40)	1.00
	Female	15 (25.9)	15 (25.9)	Reference category	
Family size	Mean (SD)	3.5 (1.0)	3.7 (1.3)	1.17 (0.85, 1.61)	0.34
Primary caregiver	Biological mother	55 (94.8)	56 (96.6)	1.53 (.25, 9.50)	0.50
	Others	3 (5.2)	2 (3.4)	Reference category	
Housing	Durable	39 (67.2)	38 (65.5)	0.93 (0.68, 1.27)	0.84
	Non-durable	19 (32.8)	20 (34.5)	Reference category	
Waste disposal	Improved	56 (96.6)	57 (98.3)	2.04 (0.76, 5.49)	0.57
	Unimproved	2 (3.4)	1 (1.7)	Reference category	
Water source	Improved	49 (84.5)	49 (84.5)	1.00 (0.66, 1.51)	1.00
	Unimproved	9 (15.5)	9 (15.5)	Reference category	
Maternal hand washing practice	Good	53 (91.4)	47 (81)	0.40 (0.25, 0.64)	0.11
	Poor	5 (8.6)	11 (19)	Reference category	
Immunization	Complete	57 (98.3)	57 (98.3)	1.00 (0.29, 3.49)	1.00
	In-complete	1 (1.7)	1 (1.7)	Reference category	
Health seeking behavior	< 1 day	55 (94.8)	49 (84.5)	0.30 (0.17, 0.51)	0.08
	> 1 day	3 (5.2)	9 (15.5)	Reference category	

¹children without a male caregiver in their lives.

*statistically significant

4.3 Multivariate analysis of variables associated with SAM

From the univariate analysis, the following factors were found to be significant: birth order, appropriate initiation of complimentary feeding, feeding frequency, amount of food fed daily, lacking dairy protein in the child's diet, lacking any kind of protein in the child's diet, a

family income of below Ksh. 10,000, owning land < 1 acre, parental employment and maternal education.

The relationship between these variables was then investigated to avoid the problem of collinearity. using Phi and Cramer V test of correlation between categorical or ordinal variables. From the results, nearly all variables were not highly correlated with each other except daily amount of feeds which had high correlation with all variables and hence excluded in the regression to avoid this problem.

Other variables excluded were: lacking dairy protein in diet because its effect would be included in the category of those lacking any protein in the diet and paternal employment because it did not represent the whole sample size.

The result of multivariate analysis showed the following factors remaining significant: birth order, appropriate initiation of complementary feeding, feeding frequency, lacking protein in diet, monthly family income of below Ksh.10,000 and owning <1 acre of land. Maternal employment and education lost association with SAM.

Table 4.5 Multivariate logistic regression of factors associated with SAM

Characteristic		AOR (95% CI)	<i>p</i>
Land acreage	< 1 acre	9.65 (6.01, 15.31)	<0.01
	>1 acre	Reference category	
Family income (Ksh.)	< 10,000	1.44 (1.02, 1.40)	0.04
	>10,000	Reference category	
Maternal employment	Reliable	1.38 (0.81, 2.37)	0.24
	Non-reliable	Reference category	
Complimentary feeding	< or > 6 months	2.87 (1.74, 4.71)	<0.01
	6 months	Reference category	
Feed frequency		0.66 (0.53, 0.82)	<0.01
Diet	No protein	2.24 (1.22, 4.11)	0.01
	Any protein	Reference category	
Birth order	Only child	Reference category	
	Otherwise	1.86 (1.21,2.85)	<0.01
Maternal education	Up to primary	1.03 (0.73, 1.49)	0.84
	Higher than primary	Reference category	

Owning <1 acre of land predisposed a child to being 9.6 times more likely to develop SAM. Inappropriate initiation of complementary feeding increased the chances of a child

developing SAM by 2.9. Lacking any form of protein in the diet made a child be 2.2 time more likely to develop SAM than one who had. Being of higher birth order increased the chance of being malnourished by 1.9. Earning <Ksh.10,000/month increased the likelihood of developing SAM by 1.4. increasing feeding frequency by 1 reduced the chances of developing SAM by 34%.

4.4 Missed opportunities for detecting SAM

93.1% of cases and 93% of controls attended MCH clinic at least once in the 6 months prior to the study. The average number of visits was 5.1 for cases and 5.5 for controls. 68.2% of controls and 62.2% of cases had monthly clinic visits in that period. Of those with documented clinic visits, 90.9% of controls and 91.1% of cases had their weight done at each visit whereas height was done for 70.5% of controls versus 66.7% of cases. Weight was plotted at each visit for 68.2% of controls and 84.1% of cases and height for 47.7% of controls and 55.6% for cases. 53.3% of cases and 4.5% of controls had a diagnosis of malnutrition in the 6 months prior to the study. Of those with cases with monthly visits in that period, only 46% had a diagnosis of malnutrition made.

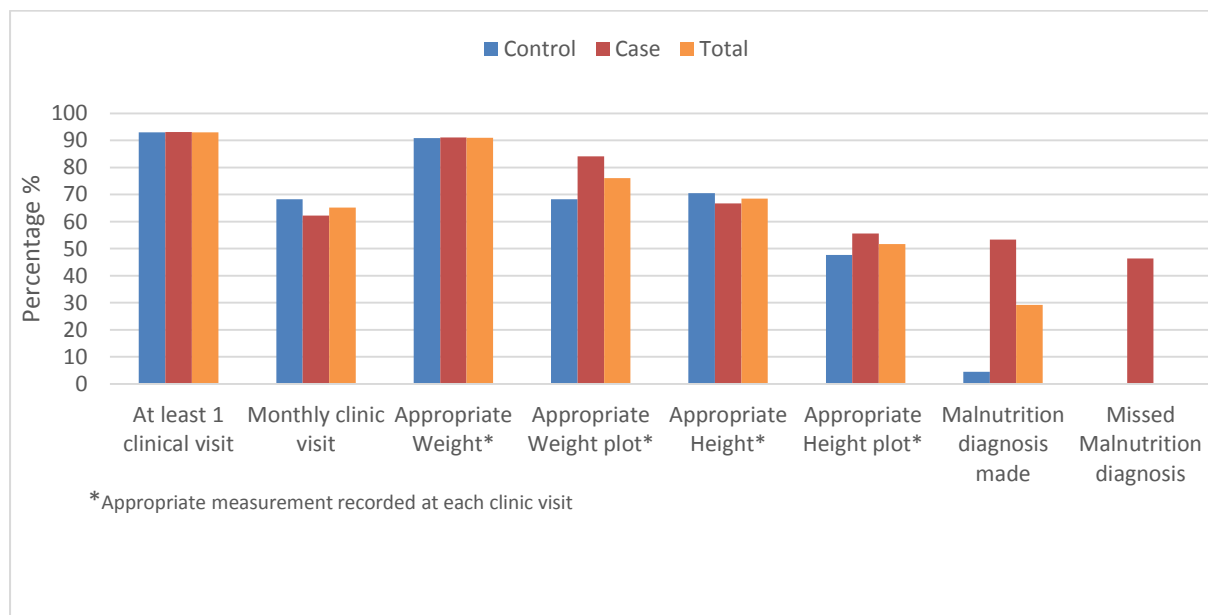


Figure 4.2: Graph showing missed opportunities for detecting malnutrition

5 DISCUSSION

After multivariate analysis, this study found the factors associated with SAM were: in socio-economic factors: owning less than 1 acre of land and a monthly family income of <Ksh.10,000; in nutritional factors: inappropriate initiation of complementary feeding, lacking any form of protein in the diet, and decreased feeding frequency; and in individual characteristics: birth order.

Owning <1 acre of land was significantly associated with SAM. This is in keeping with the results from the Fentaw *et al* study which found a significant mean difference between the average irrigable land sizes of children with normal nutritional status versus those with SAM(32). This association may be present because owning a larger piece of land means more land is available for practising farming thus increasing food security. More land may also mean there is greater capacity to earn more income for it by other means e.g. renting.

A family income of less than Ksh.10,000 per was a risk factor for a child in that household developing SAM. This is in keeping with results from various other studies that showed earning a higher income reduced the chances of developing SAM in children of that household (25,30,31,38). Having a higher level of income may mean that there are more resources to take care of the child. It leads to things like more food available and a greater variety and quality, better access to health care and a generally healthier environment.

Age at which complementary feeding is initiated was found to be significant with those initiating before or after 6 months being more likely to develop SAM. This is likely because early initiation of complementary feeding leads to loss of the advantages conferred by exclusive breastfeeding for 6 months. Late initiation on the other hand, means the child is only receiving breastmilk which after 6 months is no longer adequate to meet its nutritional requirements(6). Other studies found the age at which complementary feed were initiated did have an association with SAM (15,36,39) while others did find that it did not (25)

The composition of the food given to children contributes to maintenance of a good nutritional status. While the proportion receiving a balanced meal were the same for both cases and controls in this study, a higher proportion of cases were found to lack any form of protein in their diet and this was significant. Protein is essential for growth and development and the content in breastmilk is no longer sufficient after 6 months to support this. Lacking

any form of it in complementary feeds thus predisposes a child to develop SAM. Studies looking at food composition found that decreased amount of food in each category including proteins predisposed to SAM(25) and Ayana et al found children not given food from different categories were more likely to have SAM (30).

Increased feeding frequency was found to be protective against SAM. More frequent meals may mean that the child actually eats more than they would with fewer meals given because of the smaller capacity of a child's stomach.

The birth order was also found to have an independent association with SAM. This is in contrast to Fentaw et al who found increasing birth order was protective against SAM(32). This result in this study is likely because most of the children of lower birth order i.e. first-borns tended to be only children due to the age group recruited and the relatively low fertility rate in Embu county of 3.1(9). Fewer children in a household means that there are more resources and food available to this one child and thus reducing their chances of developing SAM.

This study showed there were multiple areas of missed opportunities to diagnose mild malnutrition early and therefore be able to manage it and thus prevent the development of severe malnutrition. The difference in MCH care and thus growth monitoring in cases and controls were comparable.

The first level is in monthly clinic visits. Those children not attending clinic monthly miss an opportunity to have their anthropometric measurements done and thus diagnose any form of malnutrition as was the case in 35% of our study participants. This responsibility lies with the caregiver and there may be a number of reasons why they may be unable to including: distance to health facility, lack of time, availability of staff at the facility, or ignorance of the need and importance to do this.

The second level is when the children attend clinic, whether their measurements are taken. The only objective way to know this is to check whether it was recorded in the booklet. Weight is more reliably taken than height (91% vs. 68.5%). If the measurements are not taken, then the child's nutritional status cannot be assessed. This means that malnutrition cannot be diagnosed. Reasons why this may not happen include: lack of equipment to take measurements, lack of staff, lack of staff motivation or knowledge, lack of MCH booklets.

The third level is plotting the recorded measurements in the appropriate chart. This is important because that is how the nutritional status is categorized. Without this step, malnutrition will not be diagnosed. Also, in those not categorized as some form of malnutrition a general trend of weight or height problems will be missed. This was not done for weight in 24% of study participants and for height in 48.3%.

Of those cases who had monthly clinic visits (28), 53.6% of them had a diagnosis of malnutrition made and had had action taken. This means that even with mothers playing their part by taking their children to clinic monthly, malnutrition can still be missed in 46.4% of children as anthropometric measurements have to be taken consistently, and plotted accurately to be able to detect malnutrition early.

Strengths of this study include the number of factors that were able to be investigated for association with SAM. We also managed to age-match for the exact age in months, cases and controls.

Weaknesses of this study were it was an observational study and causality could not be established of the factors to SAM. The data collected was also mostly self-reported subjecting it to recall bias and lacking any means of substantiation. There may also have been interviewer bias because the same interviewer that was taking the measurements and recruiting study participants was the same one then interviewing them with prior knowledge of their nutritional status.

6 CONCLUSIONS AND RECOMMENDATIONS

The factors that remained significantly associated with severe acute malnutrition after multivariate logistic regression were: owning less than 1 acre of land, inappropriate initiation of complementary feeding, lacking any protein in diet, increasing birth order, having a family income of less than Ksh. 10,000, and decreasing feed frequency. Height and weight monitoring was not done optimally at each MCH clinic visit thus making early diagnosis of malnutrition difficult.

To reduce the number of children presenting to Embu Level V hospital with severe acute malnutrition, the following recommendations can therefore be made from this study: encouraging and facilitating the appropriate initiation of complementary feeding, ensuring there is protein in these feeds and increasing the daily frequency of meals. The county health department can have programmes to educate, encourage and facilitate appropriate complementary feeding. This can be done through education at the health facility throughout pregnancy, birth and MCH clinic visits. Community health workers can also be instrumental in dispersing this knowledge directly to the community with appropriate training.

Furthermore, any steps that can be taken to improve the socio-economic status of families in the county would help alleviate this problem. This includes investing in the economic development of the county as a whole.

Mothers should be encouraged to take their children to the MCH clinic monthly. Proper and accurate growth monitoring should be done for children attending MCH clinics so as to diagnose any form and degree of malnutrition early. This will make early intervention possible and prevent more children from developing SAM. In line with this, it should be emphasised to health workers working at these clinics the importance of regular growth monitoring. More workers should be provided where they may be deficient and the appropriate equipment and supplies provided to facilitate this.

A similar study can be carried out but community-based to ensure inclusion of children from all four constituencies to further investigate the factors associated with malnutrition in the county. A study could also be done to investigate an association between poor growth monitoring and malnutrition.

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APPENDIX A

INFORMATION AND CONSENT FORM

English Version

FACTORS ASSOCIATED WITH SEVERE ACUTE MALNUTRITION IN CHILDREN AGED 6-59 MONTHS PRESENTING TO EMBU LEVEL V HOSPITAL

PART A: CAREGIVER INFORMATION SHEET

The information provided is to enable you to understand the study so that you may be able to provide informed consent for the participation of your child in the study. Please read it carefully before signing the consent form (PART B). Feel free to ask any questions you may have.

Who is doing this study?

My name is Dr. Ngina Mwangi and I am the principal investigator in this study. I am currently undertaking postgraduate training at the School of Medicine, University of Nairobi, based at the College of Health Sciences, Kenyatta National Hospital. I am doing the study with other doctors from the University of Nairobi.

What is the purpose of this study?

I am conducting this study in order to find out the factors associated with malnutrition in children admitted to Embu Level V hospital with severe acute malnutrition so we can have information specific to this area in regards to childhood malnutrition.

Why am I requesting to include your child?

I am requesting to include your child because your child has been diagnosed with malnutrition (cases) or your child's age matches with that of a child who has malnutrition (controls). He /she is eligible for the study and I would like all children to have a chance to participate in the study.

What will happen to my child if I agree to participate in this study?

If you agree, then you will be asked questions by a trained interviewer about you, your child and your family. The child will then be examined, and his/her height and weight will be taken. All this information will be recorded in a form.

Are there any risks, harms, or discomforts associated with this study?

Potential risk of being in the study is loss of privacy. We will keep everything you tell us as confidential as possible. We will use a code number to identify your child in a password-protected computer database and will keep all of our paper records in a locked secure box. However, no system of protecting confidentiality can be absolutely secure so it is still possible that someone could find out your child was in this study and could find out information about your child.

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

Every procedure that would be performed on your child is part of the routine health care offered by the hospital.

Are there any benefits if my child participates?

If you agree to take part in this study, the nutritional status of your child will be assessed, you will receive nutritional advice and any necessary treatments available will be provided. The results from this study will help the hospital and the government in general, in planning and provision of good care for other children in similar circumstances.

There are no financial benefits or cost to you or your child should you choose to participate in this study. No inducements or reimbursements will be offered.

What happens if I refuse to participate?

Participation is voluntary. You are free to decide if you want your child to participate. You are free to decline or withdraw participation of your child in the study at any time without giving reasons for withdrawing your child if you do not wish to do so. This will not affect your child's care now and in the future.

What will happen to the information collected?

The results from this study will help inform us on the problems associated with malnutrition in this hospital. The results will then be communicated to Department of Paediatrics of both University of Nairobi and Embu Level v hospital.

What if I have questions to ask about this study?

Feel free to ask me any questions now and at any other time. You can contact me for any further clarifications.

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PART B: CONSENT FORM

I , being the guardian of have understood the information in Part A above on what the study entails. I have had a chance to ask questions and they have been answered satisfactorily. I understand that I can withdraw from the study at any stage and that this will not affect me/ my child in any way.

I hereby consent to my child's participation in this study.

Parent/guardian's name: Date:Signature:.....

Investigator name:DateSignature:.....

Swahili version

SEHEMU A: MAELEZO KUHUSU UTAFITI

Maelezo haya ni ya kukujulisha kuhusu utafiti tunaofanya ili uweze kutupa idhini ya mtoto wako kushiriki katika utafiti huu. Tafadhali soma kwa makini maelezo yafuatayo kabla ya kujaza na kutia sahihi sehemu b. Unaweza kuuliza maswali yoyote ulionayo.

Utafiti huu unafanywa na nani?

Jina langu ni Dkt. Ngina Mwangi. Mimi ndiye mtafiti mku wa utafiti huu. Mimi ni mwanafunzi anaye somea shahada ya udaktari wa watoto katika chuo kikuu cha Nairobi iliyopo hospitali kuu ya taifa Kenyatta. Ninafanya utafiti huu pamoja na madaktari wengine kutoka chuo kikuu cha Nairobi.

Madhumuni ya utafiti huu?

Tunafanya utafiti huu ili tuweze kuchunguza ni mambo gani yanayo husiana na utapia mlo kwa watoto wanaolazwa hospitali ya Embu level V ili tuweze kuwa na ujuzi maalum kuhusu utapi mlo kaunti ya Embu.

Kwa nini unataka kumhusisha mtoto wangu?

Ningependa kumhusisha mtoto kwa sababu ana utapia mlo, ama ana umri sawa na mtoto aliye na utapia mlo. Hivyo kushiriki kwake kutasaidia kujua sababu zinazosababisha utapia mlo kwa watoto wenye umri sawa naye na hivyo kusaidia kupata suhulisho la sababu hizo.

Nikikubali kumhusisha mtoto wangu atafanywa nini?

Ukikubali ashiriki, wewe mzazi utaulizwa maswali na mtafiti kuhusu wewe mwenyewe, mtoto na familia yako, Mtoto atapimwa uzito, urefu na pia ataangaliwa kama ana tatizo lolote la kiafya na akipatikana na tatizo lolote atapewa matibabu kulingana na tatizo hilo.

Je, kuna madhara unahusika na utafiti huu?

Kuna uwezekano wa kupoteza usiri wa taarifa zako binafsi. Lakini kila kiwezekanavyo kuhakikisha kwamba usiri wa taarifa zako binafsi utahifidhiwa.

Pia, kuna maswali ambayo unawezayapata magumu kujibu. Ikiwa kuna swali ambalo hutaki kujibu una uhuru wa kukata kujibu.

Je, kuna manufaa yoyote mtoto wangu akishiriki kwa utafiti huu?

Ukikubali mtoto wako ashiriki, afya yake ya mlo itadhibitishwa na utapata mawaidha kuhusu mlo na atapatiwa matibabu yoyote anayohitaji. Matokeo ya utafiti huu utaweza kusaidia wanaoweza kushikwa na ugonjwa huu.

Hakuna malipo yeyote utakayopewa au kuitishwa ukiamua kushiriki katika utafiti huu.

Je nisipokubali mtoto wangu ahusike ni nini kitafanyika?

Una uhuru wa kukubali au kukata kushiriki katika utafiti huu. Hata baada ya kukubali kushiriki, unaweza kumtoa mtoto wako katika utafiti huu bila kutakiwa kupeana sababu yoyote. Uamizi wako hautudhuru huduma ya matibabu anayopata wakati wowote.

Je nitaruhusiwa niulize maswali juu ya utafiti huu?

Ndio. Ukiwa na maswali yoyote unaweza kuuliza wakati wowote ukitumia mbinu zifuatazo

DR. NGINA MWANGI

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SEHEMU B

CHETI CHA RIDHAA:

Mimi mzazi/mlezi wa....., nimeelezwa na nimeelewa na nimesoma maelezo yaliyo sehemu a kwa makini. Na pia nimeuliza maswali yangu na yamejibiwa vizuri kwa ufasaha. Hivyo nimekubali mimi na mwanangu kwa ihari kushiriki kwenye utafiti huu. Naelewa kwamba naweza jiondoa kwa utafiti huu wakati wowote.

Jina la mzazi/mlezi Tarehe

Sahihi ya mzazi/mlezi

Jina la mtafitiTarehe

Sahihi ya mtafiti

APPENDIX B

DATA COLLECTION TOOL

FACTORS ASSOCIATED WITH SEVERE ACUTE MALNUTRITION IN CHILDREN AGED 6-59 MONTHS AT EMBU LEVEL V HOSPITAL

DATE OF DATA COLLECTION/...../2017

CASE NO. CONTROL NO.

Fill in all blank spaces or tick appropriate boxes

A. Baby's particulars

- a. Age (months)
- b. Sex (tick only one appropriate box)
 - Male
 - Female
- c. Birth weight (grams)
- d. Birth order e.g. first born
- e. Age (months) of the child before index child
- f. Age (months) of the child after index child
- g. Residence (circle the appropriate ward number)

Manyatta	Runyenjes	Mbeere South	Mbeere North
1.Ruguru/Ngandori	7.Gaturi North	13.Mwea,	18.Nthawa,
2. Kithimu	8.Kagaari South	14.Amakim	19.Muminji
3. Nginda	9.Kagaari North	15.Mbeti South	20.Evurore
4.Mbeti North	10.Central Ward	16.Mavuria	
5.Kirimari,	11.Kyeni North	17.Kiambere	
6.Gaturi South	12.Kyeni South		

If from outside Embu county indicate county of origin.....

B. Mother's/caregiver's particulars

a. Relationship to the child (tick only one appropriate box)

- Biological mother
- Step mother
- Foster mother
- Aunt
- Grandmother
- Other (specify)

b. Age (years)

c. Level of education (tick only one appropriate box)

- No formal education
- Some primary education
- Completed primary education
- Some secondary education
- Completed secondary education
- Higher than secondary education

d. Occupation (tick only one appropriate box)

- Unemployed
- Casual labourer (wages)
- Formal employment (salaried)

C. Father's/caregiver's particulars (where applicable)

a. Relationship to child (tick only one appropriate box)

- Biological father
- Step father
- Foster father
- Uncle
- Grandfather
- Other (specify)

b. Age (years)

c. Level of education (tick only one appropriate box)

- No formal education
- Some primary education
- Completed primary education
- Some secondary education

- Completed secondary education
- Higher than secondary education

d. Occupation (tick only one appropriate box)

- Unemployed
- Casual labourer (wages)
- Formal employment (salaried)

D. Household access to resources

a. Land

i. Do you own land? (tick only one appropriate box)

- Yes
- No

ii. If yes, what is the approximate size? (acres)

iii. Do you practise farming on it? (tick only one appropriate box)

- Yes
- No

iv. If yes, what kind of farming is done? (tick all appropriate boxes)

Farming activity	Approximate size (acres)
<input type="checkbox"/> Food crops	
<input type="checkbox"/> Cash crops	
<input type="checkbox"/> Horticultural crops	
<input type="checkbox"/> Livestock	

b. Approximate family income per month (tick only one appropriate box)

- Ksh.
- I don't know

c. Technology. Do you have access to (tick all appropriate boxes)

- Mobile phone
- Radio
- Television
- Computer
- Internet
-

E. Feeding practises

a. Breastfeeding

- i. How soon after delivering was breastfeeding initiated? (hours)
- ii. Were any pre-lacteal feeds given? (tick only one appropriate box)
 - Yes
 - No
- iii. If yes, what was the pre-lacteal feed given?
- iv. For how long was/will the child exclusively breastfed? (months)
- v. Was the child given formula when less than six months? (tick only one appropriate box)
 - Yes
 - No
- vi. Were any of the following used when feeding the child? (tick all appropriate boxes)
 - Bottles
 - Pacifiers
 - Teats
- vii. What was/will be the total duration of breastfeeding? (months)
- viii. Is the child currently breastfeeding? (tick only one appropriate box)
 - Yes
 - No

b. Complementary feeding. When was complementary feeding introduced? (age in months)

c. Dietary intake per day. Fill in the table below

- i. For those above 6 months of age.
- ii. Before current illness (if child is unwell).
- iii. Use measuring cup to estimate amount

No.	Time	Food given	Approximate amount taken
1.			

2.			
3.			
4.			
5.			
6.			

F. Household environment

a. Type of housing (for the main household) (tick only one appropriate box)

i. Main roofing material

- Corrugated iron sheets
- Tiles
- Concrete
- Grass
- Makuti*
- Mud
- Dung

ii. Wall material

- Stone
- Bricks
- Mud
- Wood
- Corrugated iron sheets
- Grass

iii. Floor material

- Cement
- Tiles
- Wood
- Earth

b. Main water source for drinking water (tick only one appropriate box)

- Piped into house
- Piped but not into the house
- Rain harvested
- Protected well
- Protected spring
- Unprotected well
- Unprotected spring
- Stream
- River
- Water vendor
- Dam
- Lake
- Pond

c. Main waste disposal system (tick only one appropriate box)

- Main sewer
- Septic tank
- Cess pool
- VIP latrine
- Covered pit latrine
- Uncovered pit latrine
- Bucket latrine
- Bush

- d. Head of household (tick only one appropriate box)
 - Male
 - Female
- e. Family size (no. of people living in the household for more than 3 months)

G. Care

- a. When the child is unwell, how long does it take before you take him/her to a health facility (days)
- b. Do you wash your hands (tick all appropriate boxes)
 - Before handling food
 - After visiting the toilet
 - After changing baby's diaper
- c. Do you ensure that the child's hands are washed (tick all appropriate boxes)
 - Before eating
 - After visiting the toilet

H. Health services

- a. Has the child received the following vaccinations (use MCH booklet if available).
(tick all appropriate boxes)
 - BCG
 - Polio How many?
 - Pneumococcal How many?
 - Pentavalent How many?
 - Rotavirus How many?
 - Measles/ measles and rubella

I. Disease

- a. Has the child experienced any of the following in the last two weeks? (tick all appropriate boxes)
 - Fever
 - Cough
 - Fast breathing
 - Difficulty in breathing
 - Vomiting
 - Diarrhoea

J. Anthropometry

- a. MUAC (cm)

- b. Weight (kg)
- c. Height/length (cm)
- d. WHZ
- e. HAZ
- f. WAZ

K. Nutritional diagnosis (tick only one appropriate box)

- a. Acute malnutrition
 - Severe
 - Moderate
 - Mild
 - None
 - Over
- b. Chronic malnutrition
 - Severe
 - Moderate
 - Mild
 - None
 - Over
- c. Underweight
 - Severe
 - Moderate
 - Mild
 - None
 - Over

L. Other diagnosis (tick all appropriate boxes)

- a. Pneumonia
 - Severe
 - Non-severe
- b. Diarrhoea
 - Acute
 - Chronic
 - Bloody
- c. HIV
 - Positive

Negative

d. Other diagnosis (specify)

M. Gaps in early diagnosis of SAM.

Examine the MCH booklet if available

- a. In the last 6 months prior to this admission, does the child have any monthly well-baby visit to a health facility?
 - Yes
 - No
- b. If yes, how many monthly visits are there in total? (out of 6)
- c. During these visits, how many times were the following done?
 - i. Height measurement.....(out of 6)
 - ii. Weight measurement.....(out of 6)
 - iii. MUAC measurement.....(out of 6)
- d. How many times were the measurements recorded in the MCH booklet?
 - i. Height.....(out of 6)
 - ii. Weight.....(out of 6)
 - iii. MUAC.....(out of 6)
 - iv. Plotting in the weight for age graph.....(out of 6)
 - v. Plotting in the height for age graph.....(out of 6)
- e. If the weight for age, height for age or MUAC is abnormal, how many times was a diagnosis of malnutrition made?(out of 6)
- f. If a diagnosis of malnutrition is made, how many times was an intervention done?(out of 6)

APPENDIX C

BUDGET

ITEM	QUANTITY	UNIT PRICE (ksh.)	TOTAL (ksh.)
Infant weighing scale	1	25,000	25,000
Child weighing scale	1	5,000	5,000
MUAC tapes	2	250	500
Questionnaires photocopying	120	32	3840
Pens	6	10	60
Research assistant	2	10,000	20,000
Training cost			2,000
Statistician			20,000
Approval			3,000
Accommodation			10,000
Dissemination			5,000
Miscellaneous			5,000
Contingency			5,000
TOTAL			121,400

APPENDIX D

TIMEFRAME

Months	1	2	3	4	5	6	7	8	9	10
Research question										
Concept presentation										
Proposal preparation										
Supervisors' review										
Proposal corrections										
Handed to ethics										
ERC review and comments										
Data collection										
Data analysis										
Data presentation										
Final marking										
Poster presentation										
Stakeholder's meeting										